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WATER SUPPLY AND WATER QUALITY CONTROL STUDY ANDROSCOGGIN RIVER BASIN NEW HAMPSHIRE AND MAINE

Public Health Service
Boston, Massachusetts

December 1965

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WATER SUPPLY ✓ (1
AND
WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN
NEW HAMPSHIRE AND MAINE ✓

The study reported on herein has disclosed no need for water supply or water quality control storage in the proposed Pontook Reservoir on the Androscoggin River. These conclusions are based on an analysis of available data and projections of population and industrial growth from economic and demographic studies.

Prepared for
DEPARTMENT OF THE ARMY
U. S. Army Engineer Division, New England

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region I
Division of Water Supply and Pollution Control
Boston, Massachusetts

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I INTRODUCTION

Request and Authority

The U. S. Army Engineer Division, New England, in a letter dated September 29, 1961, requested that the Department of Health, Education, and Welfare give "consideration to the need for and the value of storage for regulation of stream flow for the purpose of water quality control" in the planning of multipurpose reservoirs in the Androscoggin River Basin. In compliance with this request, a letter dated January 26, 1962, was submitted to the New England Division by the Public Health Service which indicated that, under the then existing conditions, no benefits could be assigned to the proposed Pontook Project for water supply or water quality control storage.

The U. S. Army Engineer Division, New England, in a letter dated April 26, 1963, requested a restudy of the Androscoggin River for "comments on matters of interest to your agency." A letter was submitted on April 9, 1965, informing the Corps of Engineers that the pollution situation on the Androscoggin River had greatly changed since the previous Public Health Service letter and that a new study reflecting the need for and value of storage for water supply and water quality control would be forthcoming.

This study has been made in accordance with (1) the memorandum of agreement dated November 4, 1958, between the Department of the Army and the Department of Health, Education, and Welfare relative to

Title III of the Federal Water Supply Act of 1958 as amended (43 U. S. C. 390 b) and (2) the Federal Water Pollution Control Act as amended (33 U. S. C. 466 a(b)).

Purpose and Scope

The purpose of this study is to estimate the water requirements in the Androscoggin River Basin for municipal, industrial, and water quality control purposes for a 100-year period to the year 2070. Estimates are made of the value of benefits attributable to water stored for these purposes in the proposed Pontook Project on the Androscoggin River. and given in the report

Acknowledgments

The cooperation of many persons and agencies is gratefully acknowledged. Special appreciation is expressed to the following:

U. S. Army Engineer Division, New England, Waltham, Massachusetts

U. S. Geological Survey, Augusta, Maine

Maine Water Improvement Commission, Augusta, Maine

New Hampshire Water Pollution Commission, Concord, New Hampshire

Officials of Municipalities in the Study Area

Officials of Industries in the Study Area

Dr. Walter A. Lawrence, Court Appointed River Master, Lewiston, Maine

National Council for Stream Improvement, Medford, Massachusetts

New England Interstate Water Pollution Control Commission, Boston, Massachusetts

II SUMMARY AND CONCLUSIONS

Summary

1. The United States Army Engineer Division, New England, is preparing a survey report of the water resource development needs of the Androscoggin River Basin. Their report considers the feasibility of developing the multipurpose Pontook Project on the Androscoggin River at river mile (RM) 149.0.

2. The study area encompasses the natural drainage basin of the Androscoggin River. This study area includes about one-half of Coos County in New Hampshire and almost all of Androscoggin and Oxford Counties, one-third of Franklin County, and small portions of Cumberland, Sagadahoc, and Kennebec Counties in Maine.

3. The population of the study area was 156,000 in 1960 with 103,000 of these persons living in urban areas. In 1960, 136,000 persons lived in the Maine portion of the study area and 20,000 persons in the New Hampshire portion.

4. The study area is generally rural in character; however, 66 percent of the population lives in urban centers such as Berlin, Rumford, and the Lewiston-Auburn Standard Metropolitan Statistical Area (SMSA). The population of the study area has shown only a slight increase in the past two decades with some areas losing population and others showing modest increases. Generally, the very small rural towns have lost population while the urban centers that have developed a more diversified economic base have shown modest increases.

5. The study area is in a period of moderate economic growth with employment in service industries gaining in importance over the traditional manufacturing industries. The pulp and paper mills concentrated along the Androscoggin River have been expanding and modernizing their facilities. A new 500 ton per day sulfate pulp mill and a 240 ton per day paper mill are scheduled for completion at Jay, Maine, in January, 1966. With the completion of this mill, the last sulfite pulp mill in the basin will be dismantled.

6. The Androscoggin River is not used as a source of supply by any municipal water supply system in the basin. Municipal water systems obtain water either from ground water sources, protected surface water reservoirs, or a combination of both. The only treatment used by most of the municipal water supplies is disinfection with chlorine.

7. Industry relies on the Androscoggin River for power production, process and cooling water, and transport of wastes. The river is a major factor in the location and operation of many industrial concerns, especially the pulp and paper mills.

8. The most significant industrial use of water in the study area is by the pulp and paper industry. Nonetheless, total water intake at any one plant is less than 6 percent of the river's mean daily low flow of 1,550 cubic feet per second (cfs) which is exceeded 90 percent of the time at Gorham. Of the total water used in the production of pulp and paper, all but approximately 5 percent is returned to the stream.

9. No treatment is provided for the municipal wastes discharged by the population centers along the main stem of the Androscoggin and Little Androscoggin Rivers. Pulp and paper mills at Berlin, New Hampshire, and at Rumford and Chisholm, Maine, discharge untreated industrial waste to the Androscoggin River and seriously degrade the water quality of the river.

10. The Rangeley Lakes in the headwaters of the Androscoggin Basin have a total usable storage of approximately 661,000 acre-feet (ac-ft) which is controlled by Errol Dam at Errol, New Hampshire. This storage is used in an effort to maintain a flow of 1,550 cfs at Berlin, New Hampshire, for power production. In addition, Gulf Island Dam and Reservoir near Lewiston, Maine, contains approximately 25,300 acre-feet of usable storage which is used for power production.

11. Ample water is available in the basin for present and anticipated purposes; however, water quality in the Androscoggin River is badly degraded by the discharge of untreated municipal and industrial wastes. These wastes create a problem of high color, low dissolved oxygen, and taste and odor producing organics. The Androscoggin River would be of a quality suitable for most industrial and municipal purposes if these wastes are given adequate treatment.

12. The water quality of the proposed Pontook Reservoir will be acceptable for municipal, industrial, recreational, fish and wildlife, and agricultural uses.

Conclusions

1. To insure continued growth and development of the study area, the water quality of the Androscoggin River must be improved.
2. The study area's population is expected to reach 207,000 by the year 2020 and 234,000 by the year 2070 with 181,000 and 203,000 of these people living in Maine in the years 2020 and 2070, respectively. The major portion of these people will be located along the main stem of the Androscoggin River.
3. Estimated future municipal and industrial water supply needs along the Androscoggin River will be 370 million gallons per day (MGD) in the year 2020 and 426 MGD in the year 2070. Of these needs 350 MGD will be returned to the river in the year 2020 and 403 MGD in the year 2070.
4. The total Androscoggin River Basin's municipal and industrial water supply needs will be 392 MGD in 2020 and 454 MGD in the year 2070.
5. Under existing conditions, the Androscoggin River can supply 1,000 MGD at Rumford, Maine, 98 percent of the time. There is ample water in the Androscoggin River to supply all projected water needs in the basin to at least 2070.
6. There is no need for additional water storage for municipal or industrial water supply on the main stem of the Androscoggin River.

7. Estimated future discharges of adequately treated municipal and industrial wastes along the Androscoggin River will be 246,000 Population Equivalents (PE) per day in the year 2020 and 272,000 PE per day in 2070.

8. The total Androscoggin River Basin's municipal and industrial waste load after secondary treatment will be 273,000 PE per day in 2020 and 306,000 PE per day in 2070.

9. The per capita contribution of 5-day, 20°C. biochemical oxygen demand (BOD) will increase from 0.17 pounds per capita per day (lbs/cap/day) in 1964 to 0.24 lbs/cap/day in 2000 and 2020 and to 0.27 lbs/cap/day by 2070. These increases would result from the expected increased use of individual garbage disposal units, more automatic washers, and increased utilization of municipal sewerage facilities by industry.

10. With the assumption that all municipal and industrial wastes discharged in the Androscoggin River Basin will receive secondary treatment, or its equivalent, it is concluded that the water quality of the Androscoggin River, as measured by dissolved oxygen, will be satisfactory for all legitimate uses through the year 2070.

11. No present or future need has been found for storage in the Androscoggin River Basin for water supply or water quality control; therefore, no benefits can be assigned to storage for these purposes in the proposed Pontook Project.

III PROJECT DESCRIPTION

The New England Division of the United States Army Corps of Engineers is preparing a survey report on the Androscoggin River Basin. Projects were considered on the Swift, Dead, Ellis, and Androscoggin Rivers; but economic studies found all but a multipurpose power recreation and flood control project on the main stem of the Androscoggin to be lacking in economic justification. The proposed Pontook Project, at river mile 149.0, would consist of a main dam with full pool at elevation 1,220 feet above mean sea level (MSL), impounding 238,000 acre-feet of water and a smaller reregulating dam and reservoir downstream impounding 16,300 acre-feet. The Study Area Map (Figure VI) at the back of this report shows the location of the Pontook Project.

At full pool, a lake approximately 16 miles long with a surface area of 7,470 acres will be created by the main dam. Within the main reservoir, 141,000 acre-feet of storage with a drawdown of 23 feet is used for power production and flood control, and 97,000 acre-feet below elevation 1,197 is maintained as dead storage. Flows from the main dam will be peaked with maximum flows through the powerhouse of 40,000 cfs resulting in the generation of 300,000 KW of electricity.

The reregulating dam has a maximum pool area of 1,160 acres which runs back to the main dam and contains 15,000 acre-feet of usable storage. The purpose of the reregulating dam is to take the high peak flows from the main dam and reestablish a uniform flow condition in the river over a 24-hour period. The reregulating pool will fluctuate between elevation 1,121 and 1,101 MSL and will provide a minimum average annual regulated river flow of 1,675 cfs.[35]

IV STUDY AREA DESCRIPTION

The study area encompasses the natural drainage basin of the Androscoggin River and includes about one-half of Coos County in New Hampshire and in Maine almost all of Androscoggin and Oxford Counties, about one-third of Franklin County and a small portion of Cumberland, Sagadahoc, and Kennebec Counties.

An economic base study for New England has recently been completed by Arthur D. Little, Inc., for the Corps of Engineers. This study makes economic projections for all of New England,[21] each New England State,[22] and sub-state areas.[23] The sub-state areas were selected in an effort to:

1. "Identify major concentrations of population and economic activity;
2. provide a useful areal arrangement for data on river basin studies; and
3. minimize the problems of data availability and high costs that would arise with a breakdown of the region into a large number of smaller areas."[23]

The boundaries of these sub-state areas have been used to divide the Androscoggin River study area into three subareas for the purpose of economic, demographic, and engineering studies. Figures A-1 and A-2 in the Appendix show the boundaries of the Androscoggin River Basin and the subareas; and Tables A-1, A-2, and A-3 describe some of the more prominent features of the subareas. The Androscoggin River Basin subareas will hereafter in this report be referred to as NH-3A, Me-2A, and Me-RA for NH-3, Me-2, and Me-R, respectively.

Geography

The Androscoggin River Basin is located in the southwestern part of Maine and the northeastern part of New Hampshire. It extends from the Canadian border at the boundary between the states of Maine and New Hampshire to Merrymeeting Bay, eight miles below tidewater at Brunswick, Maine. The basin has a length of 110 miles and a width of 65 miles and covers an area of 3,450 square miles of which 2,730 are in Maine and 720 are in New Hampshire.

Topography

The Androscoggin River has its source at the Canadian border in the northwest corner of Maine and along the northernmost section of the border between Maine and New Hampshire. The river drains the eastern slopes of the Presidential Range of the White Mountains and is fed by fast-running mountain streams which are a source of extremely high run-off during periods of intensive rain, snowmelt, or a combination of both.

The Androscoggin River proper starts at Errol Dam at the outlet of Umbagog Lake in the town of Errol, New Hampshire, although its principal headwater tributaries extend about 50 miles north of the lake. The main stem is 169 miles long between Errol Dam and its mouth at Merrymeeting Bay over which it descends a total of 1,245 feet in the 161 miles above tidewater. The river has two steep drops, 240 feet in 2.5 miles at Berlin, New Hampshire, and 180 feet in 1.6 miles at Rumford, Maine. Of the 1,094 foot fall of the main stem of the river between Sawmill Dam in Berlin and Brunswick, 789 feet have been developed for hydroelectric power purposes.

Climate

The climate of the basin is characterized by relatively cool summers and long, cold, snowy winters, especially in the inland areas. The temperatures range from extremes of slightly over 100°F to below -30°F on occasion. The average annual temperature varies from about 45°F near the coast to 40°F in the headwaters. About 160 frost free days are to be expected near the coast and about 110 days in the higher portions of the basin. The mean annual precipitation in the basin is about 40 inches and varies from about 35 inches in the northernmost areas to as high as 60 inches in the White Mountains. Average snowfall varies from 80 inches near the coast to 170 inches in the headwaters.

Lying in the path of the "prevailing westerlies", which often bring cyclonic distribances that approach from the west and southwest, the basin is subject to frequent but short periods of heavy precipitation. The basin is also exposed to occasional coastal storms, some of tropical origin, that travel up the Atlantic seaboard.

Principal Communities and Industries

The principal communities along the Androscoggin River are Berlin and Gorham in New Hampshire, and Rumford, Mexico, Lewiston, Auburn, Lisbon, and Brunswick in Maine. The principal industry in the upper basin is pulp and paper products. The Brown Company has a pulp and paper mill in Berlin, New Hampshire; the Oxford Paper Company has a mill in Rumford, Maine; and the International Paper Company has mills at Riley, Chisholm, Livermore Falls, Maine, and a recently completed mill at Jay, Maine. In the lower portion of the basin at Lewiston, Auburn, and Brunswick, industry is diversified with textiles and shoe manufacturing being the most important. The Androscoggin River is a factor in the industry of the basin as its water is used by virtually all for power production, processing, washing, cooling, and the transport of waste products.

Table A-4 in the Appendix gives a list of important points along the Androscoggin River and their respective river miles.

V WATER RESOURCES OF THE ANDROSCOGGIN RIVER BASIN

Errol Dam on the Androscoggin River controls the runoff from 1,045 square miles of drainage area with a usable storage of 661,100 acre-feet contained in the seven lakes of the Rangeley Lake System.

The development of the storage in the seven Rangeley Lakes of Kennebago, Rangeley, Mooselookmeguntic, Upper and Lower Richardson, Umbagog and Aziscohas Lakes began over 100 years ago with the construction of timber and earth dams at their natural outlets. The storage thus obtained by raising the lakes was used to control the flows in the river and thereby increase the amount of power that could be obtained for the operation of downstream plants.

Quantity of Water Available

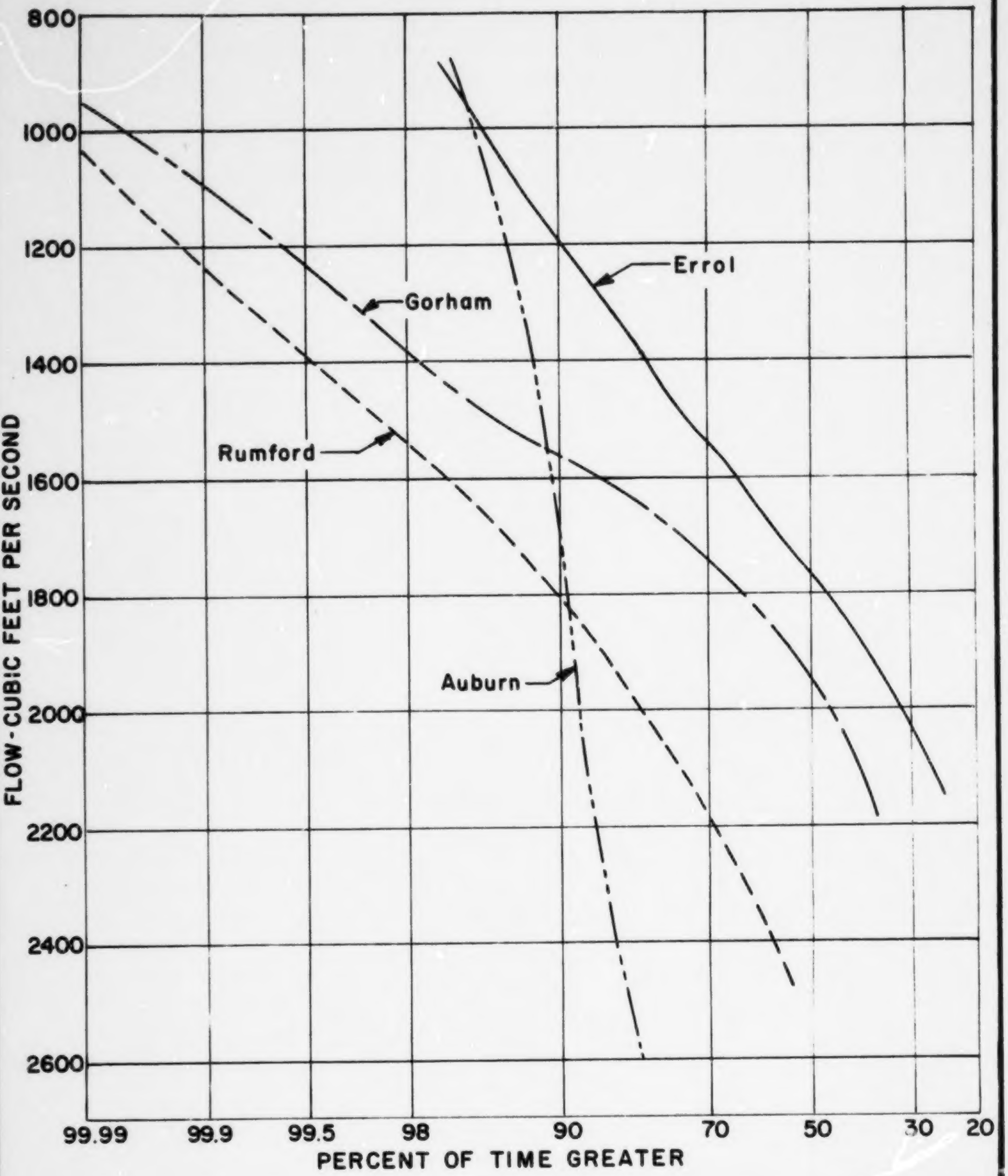
Surface Water: Releases of water from Errol Dam are controlled by the Union Water Power Company, a subsidiary of the Central Maine Power Company. The Union Water Power Company has had an agreement for some 60 years with several downstream hydroelectric power producers to maintain, insofar as possible, a minimum flow of 1,550 cfs at the U. S. G. S. gage at Gorham, New Hampshire. The water thus released is used by downstream water users for hydroelectric power generation, processing, cooling, and transportation of wastes.

The success with which the flow of the Androscoggin River has been regulated is shown by the Flow Frequency Curves of Figure I. These curves show that a mean daily flow of 1,490 cfs has been recorded at the Gorham gage 95 percent of the time during the 51 years of record.

Only infrequently since 1929 have average monthly flows less than 1,550 cfs been experienced at Gorham. These periods were in the Spring of 1930; from August, 1941, through March, 1942, inclusive; in the winter of 1947-48; the fall of 1948; and the fall of 1949.[13/] An analysis of the 70 years of record available for the U. S. G. S. gage at Rumford was made to determine the distribution of monthly flows. The average median monthly flow is 3,448 cfs with lowest median monthly flows of 2,086 cfs and 2,147 cfs occurring respectively in August and September. Table 1 shows the flow characteristics of the important U. S. G. S. gaging stations in the basin and Figure II shows Runoff Frequency Curves for the intervening drainage area between the main stem gaging stations. A runoff of 0.25 cfs/square mile can be expected 95 percent of the time between Errol and Rumford which correlates very well with the flow frequency curves of Figure I. It is readily apparent that the Androscoggin River has a very dependable flow regime due to the regulated releases from the Rangeley Lakes and that runoff below Errol is only a minor contributor to the river's flow during drought periods.

All the available storage in the Androscoggin River Basin is shown in Table 2. From this table it is evident that with the exception of the Rangeley Lake System, Gulf Island Pond is the largest storage facility in the basin.

Gulf Island Pond contains 25,300 acre-feet of usable storage controlled by the Gulf Island Dam at river mile 34.8 just above Lewiston, Maine. The Gulf Island Project is operated in conjunction with the much smaller Deer Rips Project at river mile 33.7 by the Central Maine



WATER SUPPLY AND WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN, N.H., ME.

FLOW FREQUENCY CURVES

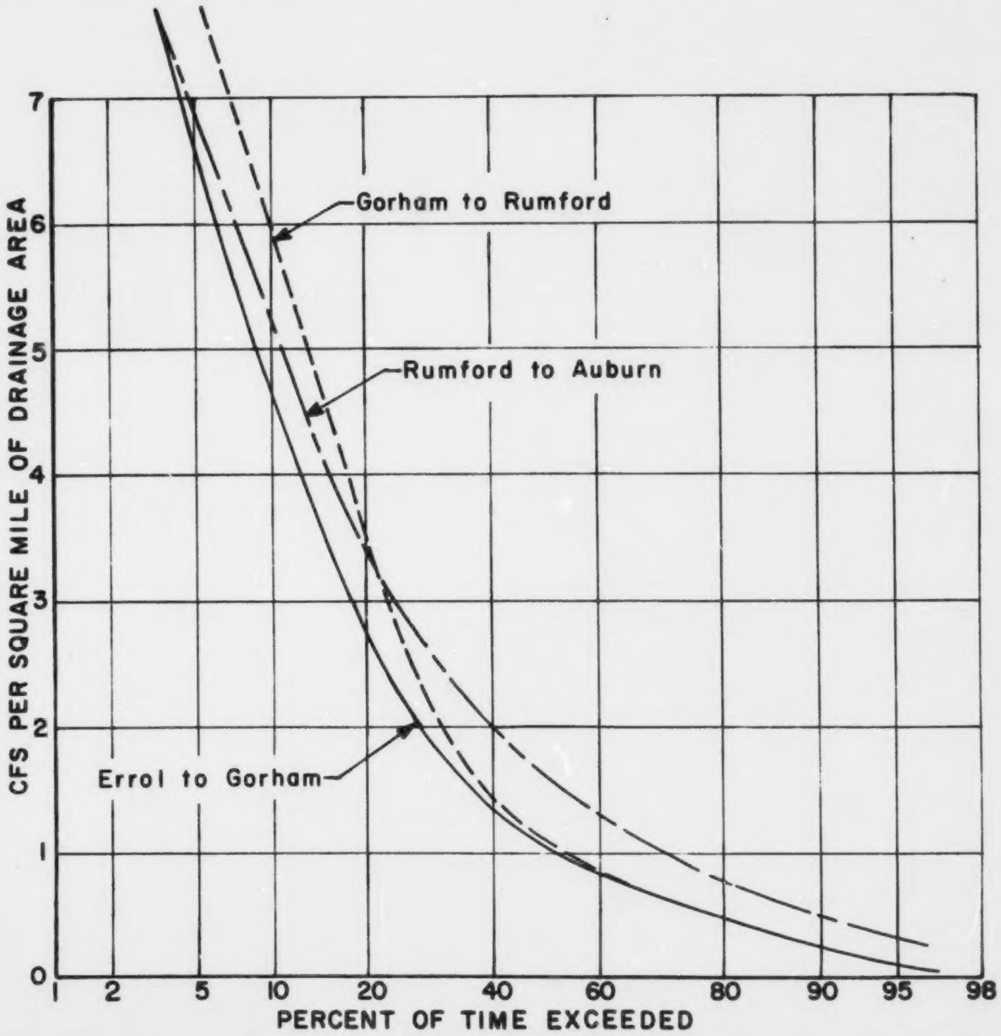
U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE I

TABLE 1

STREAMFLOW RECORDS[46/]

Gaging Station	River Mile	Drainage Area (Sq. Mi.)	Length of Record (years)	Daily Discharge (cfs)		
				Mean	Maximum	Minimum
Androscoggin River @ Errol, N. H.	168.6	1045	59	1886	15,700 6/18/43	Leakage Various Times
Androscoggin River @ Gorham, N. H.	134.4	1363	51	2445	20,000 6/18/17	795 3/15/11
Androscoggin River @ Rumford, Maine	87.5	2067	72	3679	74,000 3/20/36	625 3/27/11
Androscoggin River @ Auburn, Maine	28.4	3257	36	6000	135,000 3/20/36	340 9/28/41
Little Androscoggin River @ Auburn, Maine	N. A.	328	24	553	16,500 3/28/53	14 10/14/49



NOTE:

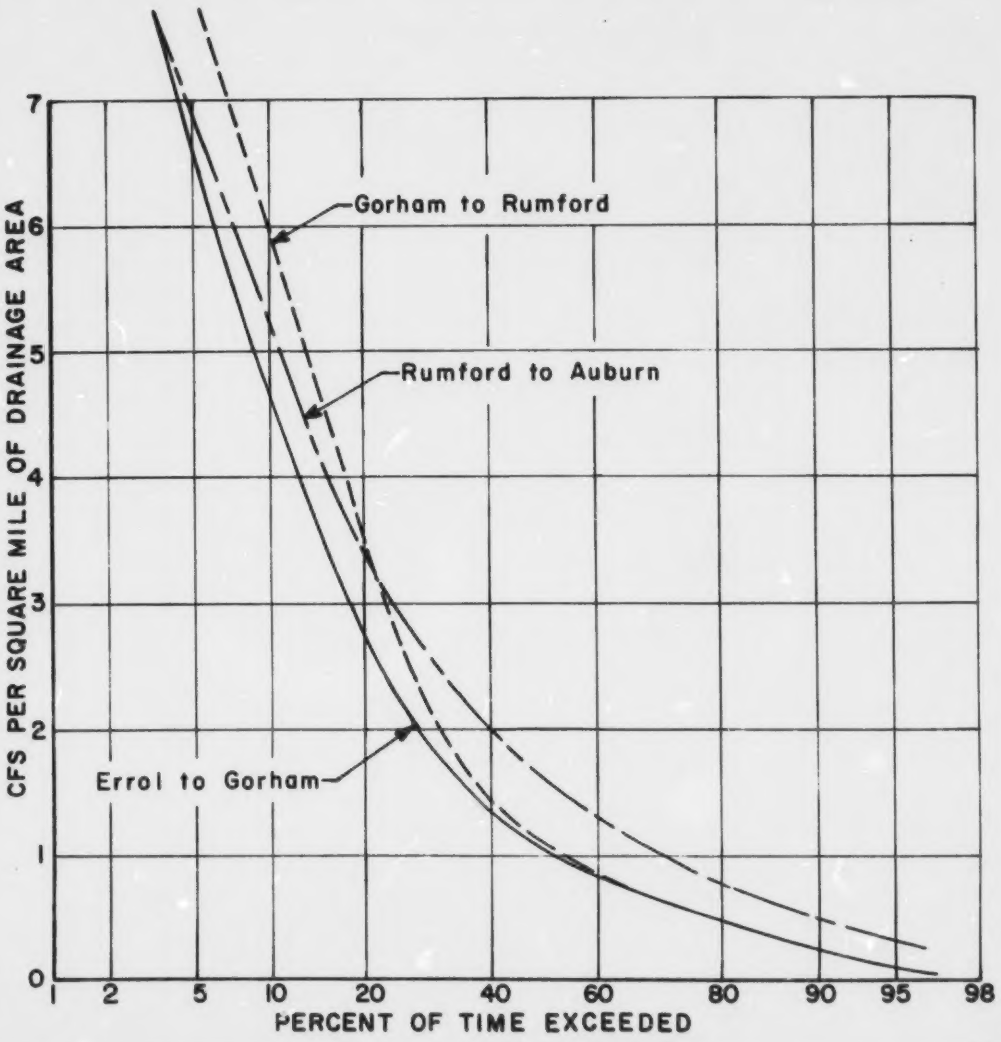
CURVES BASED ON FLOW RECORDS
OF U.S. GEOLOGICAL SURVEY
1951 TO 1960

WATER SUPPLY AND WATER QUALITY CONTROL STUDY

ANDROSCOGGIN RIVER BASIN
RUNOFF FREQUENCY CURVES

U. S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE II



NOTE:

CURVES BASED ON FLOW RECORDS
OF U.S. GEOLOGICAL SURVEY
1951 TO 1960

WATER SUPPLY AND WATER QUALITY CONTROL STUDY

ANDROSCOGGIN RIVER BASIN
RUNOFF FREQUENCY CURVES

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE II

TABLE 2

USABLE STORAGE
IN THE
ANDROSCOGGIN RIVER BASIN [48]

Reservoir	Drainage Area (sq. mi.)	Drawdown (feet)	Usable Storage (acre-feet)
Upper Androscoggin Basin			
Kennebago	101	4.0	16,600
Rangeley Lake	99	4.0	30,700
Mooselookmeguntic Lake	182	12.2	192,200
Upper and Lower Richardson Lakes	90	17.5	130,700
Aziscohos Lake	214	45.0	220,200
Umbagog Lake	359	9.5	70,700
Total above Errol, New Hampshire	1,045		661,100
Lower Androscoggin Basin			
Gulf Island Pond	2,862	10.0	25,300
Total Main Stem, Androscoggin River			686,400
Little Androscoggin River			
Pennesseewassee Lake	23	5.0	4,400
Thompson Lake	44	5.0	21,800
Total Little Androscoggin River			26,200
Other Tributaries			
Lake Auburn	17	6.0	13,300
Androscoggin River Basin Total			725,900

Power Company for the generation of electricity. The following, quoted from the Federal Power Commission Report to the Natural Resources and Power Subcommittee of the U. S. House of Representatives, describes the operation of the Gulf Island Project.

> "During periods of low flow, the available pondage at Gulf Island is used for peaking 24-hour inflow into 16 hours on a daily basis and also peaking 7-day inflow into five days on a weekly basis. Under this method of operation, flows from Gulf Island are completely shut off for eight hours daily and longer over weekends. During periods of normal river flow, Gulf Island operates as a base load plant during week days."14/

As a result of the fluctuations in power demand exerted on these projects, the river is subject to wide variations in flow at Lewiston, Maine.

In the Little Androscoggin River Basin, Pennesseewassee Lake in Norway is operated by the Central Maine Power Company; and Thompson Lake in Oxford is operated by the Robinson Manufacturing Company. Releases of water made from the available storage in these two lakes benefit downstream plants on the Little Androscoggin River. Lake Auburn is the water supply for Lewiston and Auburn, and it has a safe yield of 12 MGD.

In total there are 23 dams on the main stem of the Androscoggin River between Errol, New Hampshire, and tidewater at Brunswick, Maine.13/ All of the impoundments, except Gulf Island, have very little storage and are operated essentially as run of the river projects. These dams have a significant effect on the waste assimilative capacity of the river due to the slower velocities through the ponds and the resulting deposit of solids and reduced atmospheric reaeration.

Groundwater: Most of the Androscoggin River Basin is underlain by bedrock, consisting of granites, gneisses, schists, and slates. The bedrock has an overburden of glacial till which is composed of unstratified mixtures of clay, sand, gravel, and boulders. The thickness of this blanket of till varies widely with the thicker deposits occurring in the stream and river valleys.

The bedrock formations are not good aquifers and water wells completed in these formations generally yield less than 50,000 gallons per day (gal/day). However, adequate groundwater to meet the needs of individual rural homes and farmsteads for domestic water, stock watering and spraying can be developed from the bedrock formations.

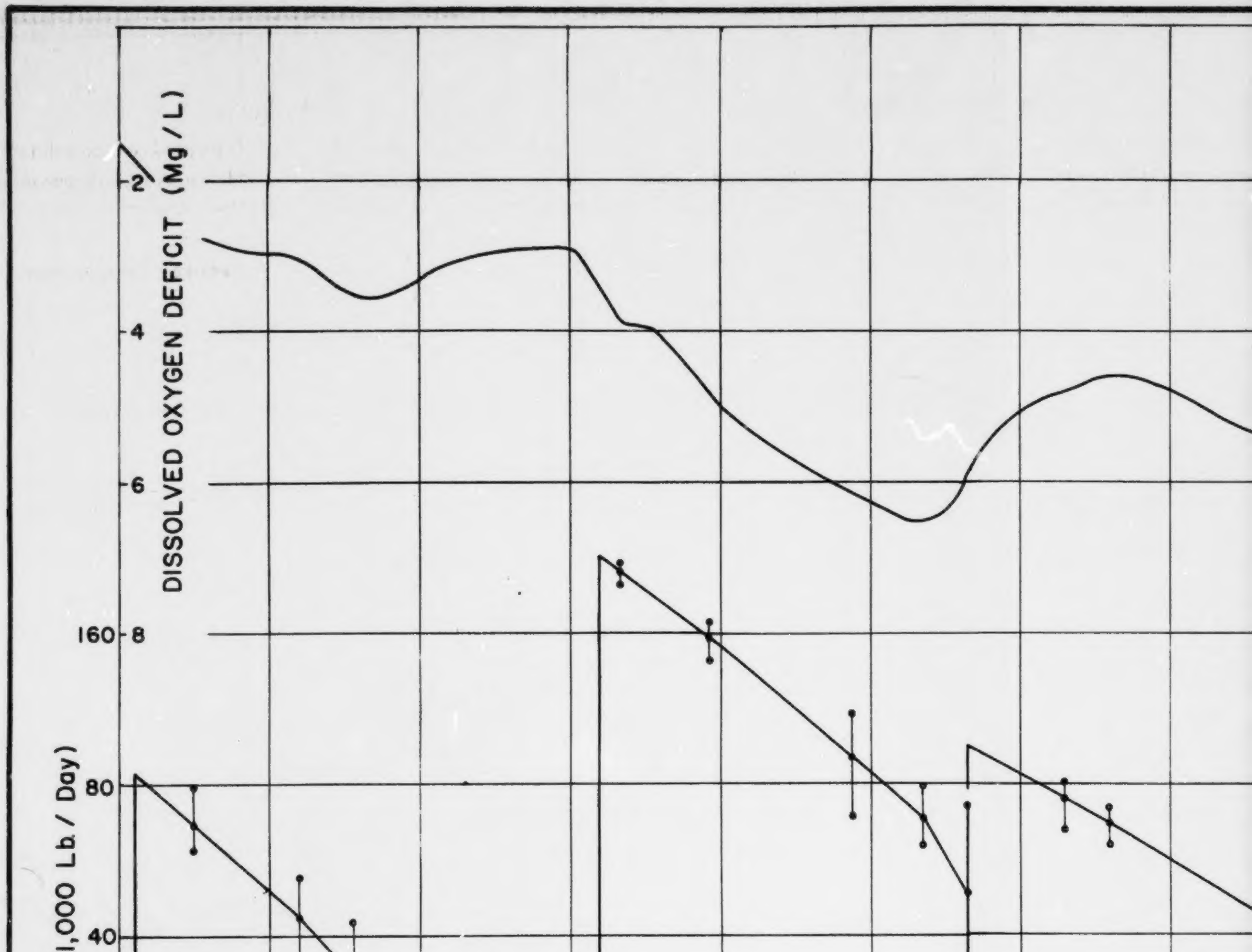
Along the main stem of the Androscoggin River and many of its major tributaries, groundwater supplies yielding 50,000 to 1,000,000 gal/day can be developed from the deposits of glacial till and stratified drift. Limited areas exist in the basin which can be developed to yield more than 1,000,000 gal/day.[29/]

Quality of Water Available

Surface Water: The natural surface waters of the basin are soft, relatively low in suspended material and mineral content and are generally suitable for domestic, agricultural, and industrial uses. Hardness of the natural waters is usually less than 50 ppm as $Ca\ CO_3$ with alkalinity generally being less than 15 ppm as $Ca\ CO_3$. The pH of the basin's surface waters is slightly acidic with a range of 5.6 to 7.0.

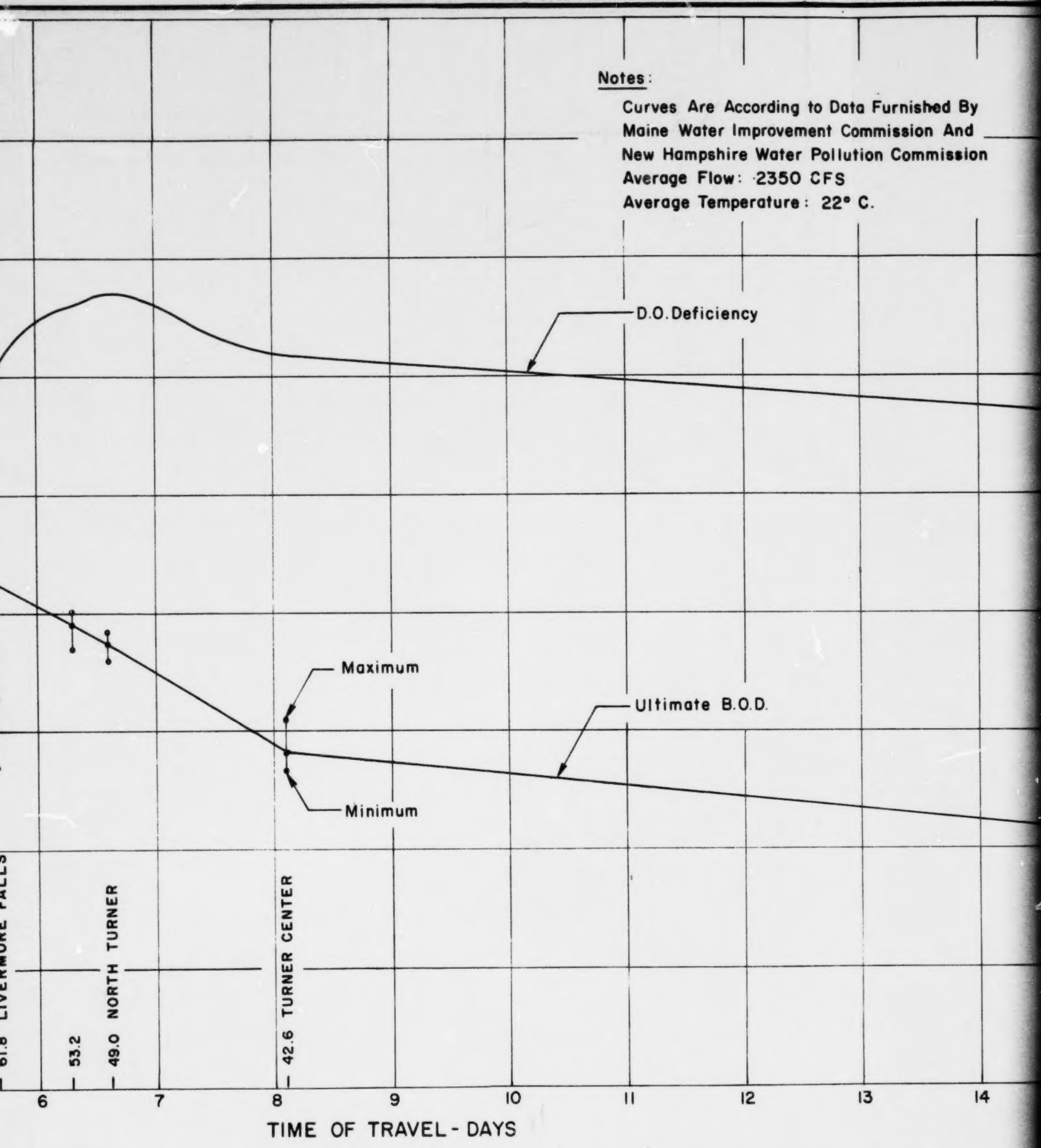
The main stem of the Androscoggin River from Berlin, New Hampshire, to tidewater is grossly polluted by the discharge of untreated municipal and industrial wastes. At the present time, none of the municipalities or industries along the Androscoggin treat their waste before discharge.[44,45] Over 95 percent of the total waste load entering the river above Lewiston, Maine, emanates from the pulp and paper mills at Berlin, New Hampshire, Rumford, Maine, and Livermore Falls, Maine. These wastes reduced the dissolved oxygen in the river at Jay, Maine, (RM 63.8) to an average of 3.0 mg/l and at Gulf Island Dam (RM 34.8) to an average of 1.5 mg/l during the summer of 1964. A profile of dissolved oxygen deficit (below saturation) and waste loading is shown on Figures III and IV for July, 1964, and August, 1964, respectively. The data for these curves was collected and analyzed by the Maine Water Improvement Commission and the New Hampshire Water Pollution Control Commission. The curves shown represent the average of 12 samples collected on consecutive days at each sample site during July, 1964, and again in August, 1964. The wide variation in the sampling results is illustrated by the maximum and minimum values shown at each sample site for the biochemical oxygen demand (BOD).

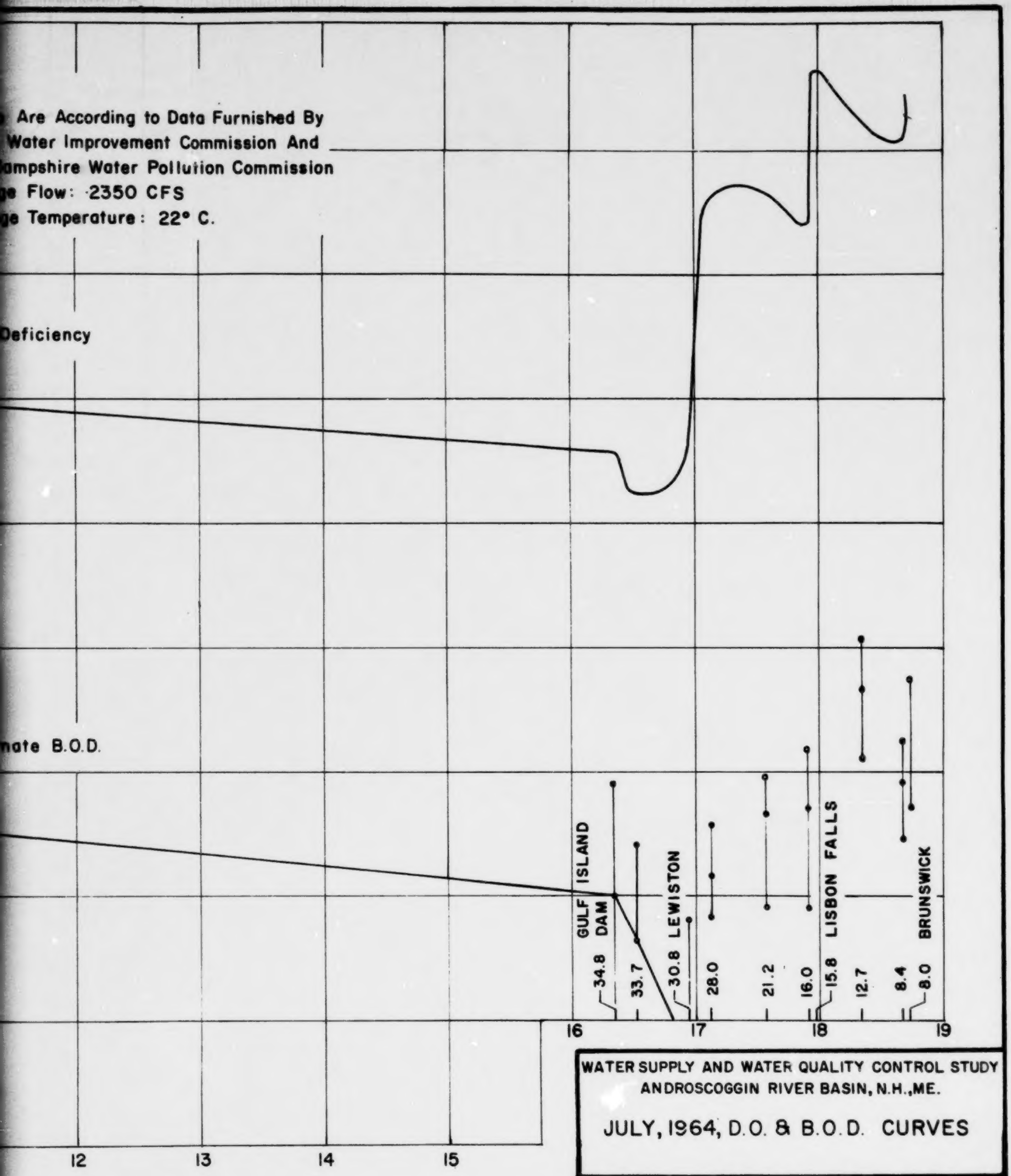
The organic industrial wastes discharged to the Androscoggin River impair its usefulness for fish and wildlife habitat, recreation, and public and industrial water supplies.[32] These wastes also produce deposits along the river banks, floating solids, discoloration of the water, and foul odors, thereby seriously degrading the aesthetic value of the river.[33]



DISSOLVED OXYGEN DEFICIT (Mg/L)
ULTIMATE B.O.D. (1,000 Lb./Day)
2
4
6
160
8
80
40
20
10
5
0
1
2
3
4
5
6
7
BERLIN
GORHAM
GILEAD
BETHEL
RUMFORD POINT
RUMFORD
DIXFIELD
GILBERTVILLE
LIVERMORE FALLS
NORTH TURNER
138.8
137.0
130.4
119.2
109.4
96.8
87.6
86.0
82.0
78.6
74.8
71.7
66.6
63.8
61.8
53.2
49.0

28


Notes:
Curves Are According to Data Furnished By Maine Water Improvement Commission And New Hampshire Water Pollution Commission
Average Flow: 2350 CFS
Average Temperature: 22° C.
D.O. Deficiency
Maximum
Ultimate B.O.D.
Minimum
LIVERMORE FALLS
53.2
49.0 NORTH TURNER
42.6 TURNER CENTER
6
7
8
9
10
11
12
13
14
TIME OF TRAVEL - DAYS

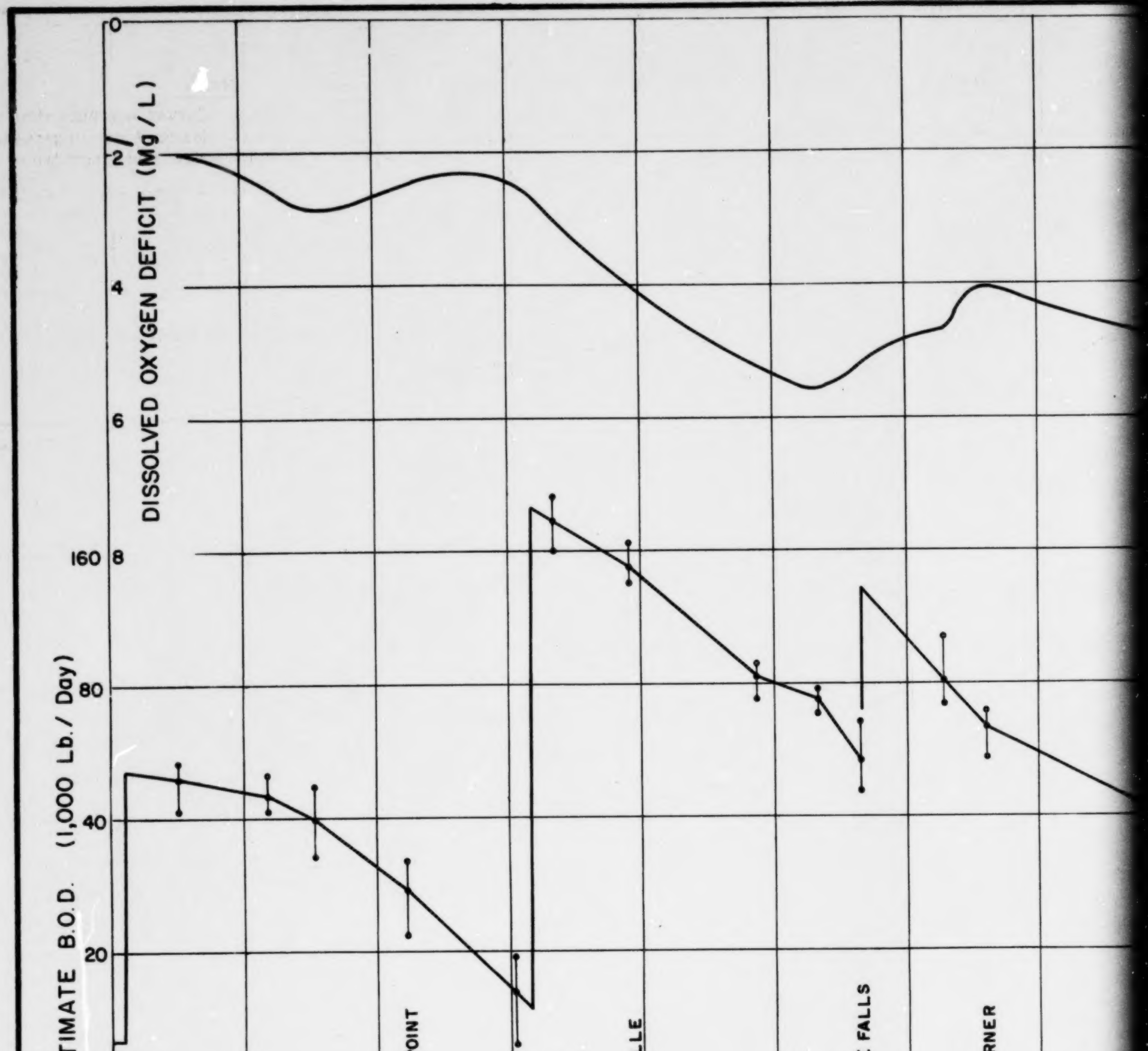


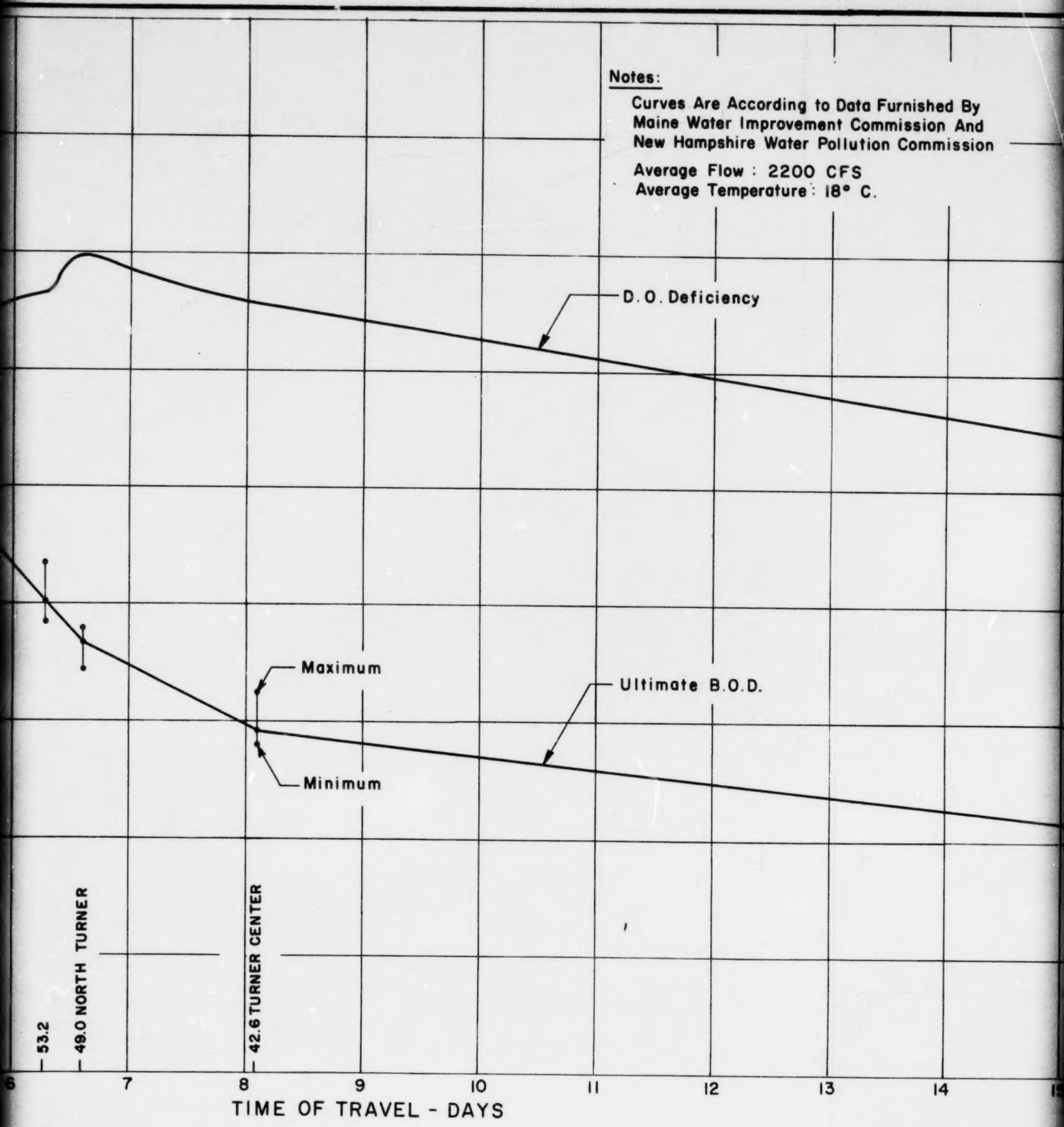
WATER SUPPLY AND WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN, N.H., ME.

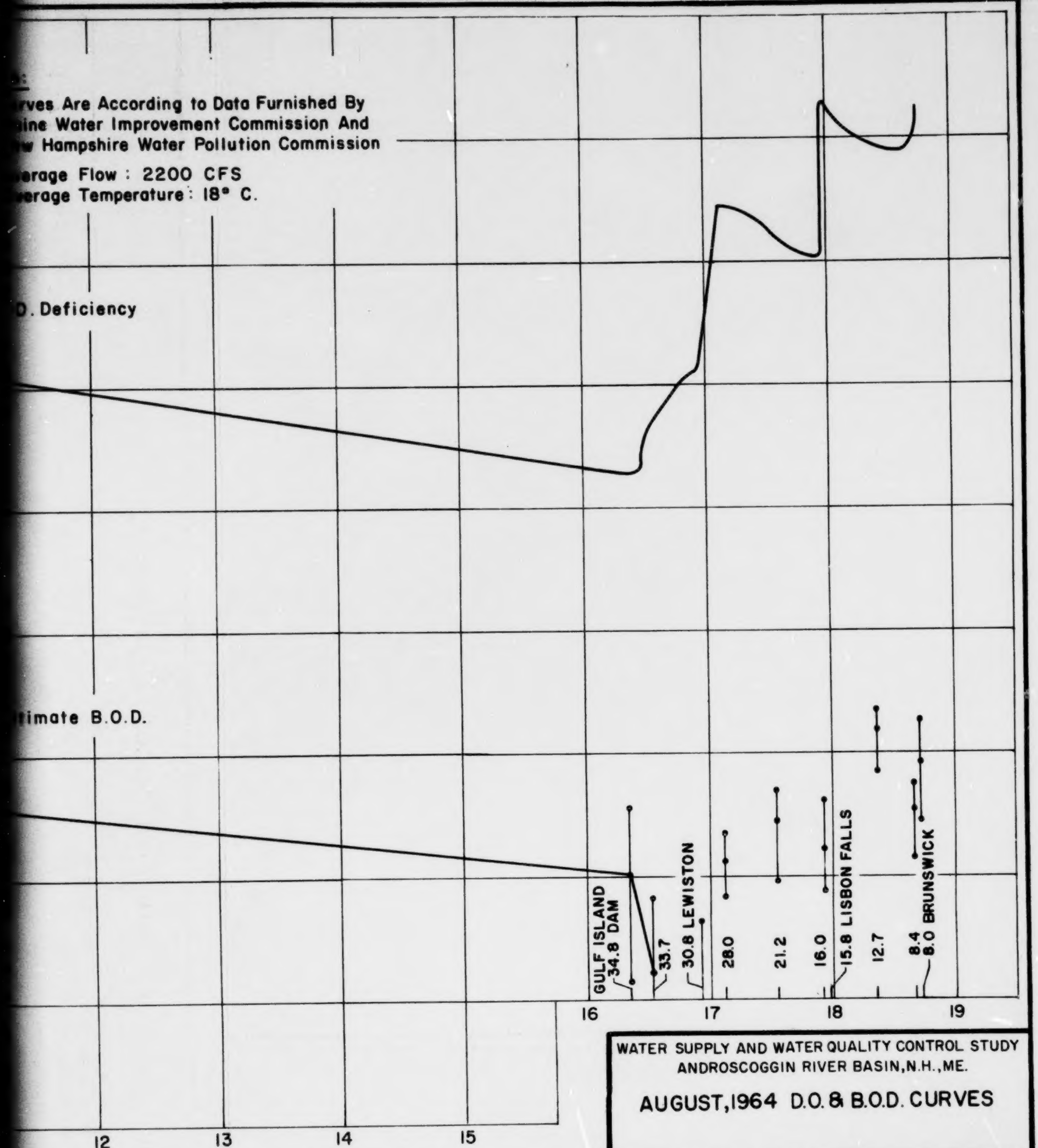
JULY, 1964, D.O. & B.O.D. CURVES

U. S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE III


DISSOLVED OXYGEN DEFICIT (Mg / L)
0
2
4
6
8
ULTIMATE B.O.D. (1,000 Lb. / Day)
5
10
20
40
80
160
0
1
2
3
4
5
6
7
138.8
137.0 BERLIN
130.4 GORHAM
119.2 GILEAD
109.4 BETHEL
96.8 RUMFORD POINT
87.6
86.0 RUMFORD
82.0 DIXFIELD
78.6
74.8
71.7 GILBERTVILLE
66.6
63.8
61.8 LIVERMORE FALLS
53.2
49.0 NORTH TURNER


Notes:
Curves Are According to Data Furnished By Maine Water Improvement Commission And New Hampshire Water Pollution Commission
Average Flow : 2200 CFS
Average Temperature : 18° C.
D. O. Deficiency
Ultimate B.O.D.
Maximum
Minimum
53.2
49.0 NORTH TURNER
42.6 TURNER CENTER
7
8
9
10
11
12
13
14
TIME OF TRAVEL - DAYS



WATER SUPPLY AND WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN, N.H., ME.

AUGUST, 1964 D.O. & B.O.D. CURVES

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE IV

Some improvement in the Androscoggin River's water quality, as measured by dissolved oxygen, has been accomplished in the past few years due to the elimination of waste sulfite liquor discharges at Berlin, New Hampshire, and Rumford, Maine. Brown Company has recently announced plans for a neutral sulfite pulp mill with the spent liquor being reclaimed in the sulfate pulp mill recovery system. The discharge of waste sulfite liquor to the Androscoggin River should be only a memory of the past after the new International Paper Company's 500 ton/day sulfate pulp mill goes into operation in early 1966.

An enforcement conference on the interstate pollution of the Androscoggin River was convened at Portland, Maine, on February 5, 1963. As a result of this conference, the Secretary of Health, Education, and Welfare recommended that the classification of the river for future highest use by submitted by the responsible state water pollution control agency to the respective legislatures of New Hampshire and Maine during the 1967 session.

Classification of the Androscoggin River's main stem will permit the states of New Hampshire and Maine to require sufficient treatment of all waste discharges so that the river's water quality will meet the classification standards. State laws in New Hampshire and Maine require the respective state water pollution control agency to submit to the legislature recommendations on a stream's classification standards; however, the legislature may exercise its prerogative and classify the stream as it sees fit. In some cases involving a highly polluted stream, the legislature has given the stream a lower classification than that recommended to it thereby making significant water quality improvement difficult to achieve. Many people in New Hampshire and Maine, including conservationists, sportsmen, and others are working to gain acceptance of a "C" classification for the Androscoggin River, which would require 5.0 mg/l of dissolved oxygen along the River's entire length. Such a classification would make it mandatory for the municipalities and industries along the river to institute treatment of their wastes. A chart showing the classification standards used by the N. E. Interstate Water Pollution Control Commission is shown in Table A-14 of the Appendix.

Groundwater: The groundwaters of the Androscoggin River Basin are slightly harder and more highly mineralized than the surface waters; however, the groundwater is generally suitable for all domestic, agricultural, and most industrial uses. Iron content in the Brunswick, Maine, and Berlin, New Hampshire, areas is excessive and in the Lisbon Falls Area the hardness is greater than 100 ppm as Ca CO_3.29/ However, adequate groundwater of good quality can be found in these areas as evidenced by the fact that Brunswick and Lisbon Falls are completely supplied by groundwater and Berlin is partially supplied by groundwater.

Much of the groundwater in the vicinity of Rumford, Maine, contains appreciable quantities of radon gas and its daughter products. In many cases the amount of radon exceeds the recommended non-occupational exposure level of 6,000 pc/l (pico curies per liter).* Because of the radon content, all potential ground water supplies in the Rumford area are carefully

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* Hursh, John B., et. al., "Fate of Radon Ingested by Man," Health Physics, Vol. 11, No. 6.

screened by the Maine State Health Department. Only trace amounts of radon have been found in the area's surface waters; and as a result, the Health Department has recommended the development of surface water supplies when at all possible.

Preliminary investigations conducted several years ago indicated significant concentrations of radium might be present in the groundwaters of the Rumford area.15/ Additional sampling, analysis, and study have now been completed; and it has been concluded by the United States Public Health Service and the Maine Health Department that except in isolated cases, no appreciable concentrations of radium are to be found in the Rumford area groundwaters.

VI THE ECONOMY

Estimates of future municipal and industrial water use and waste discharges in the study area involve an appraisal of the area's present and future population and industrial growth potential. Future economic growth in the Androscoggin River Basin will be determined by the conditions of the local, regional, and national economy, the development of natural and human resources of the basin and the enhancement and protection of the basin's water resources. The previously mentioned Projective Economic Study of New England by A. D. Little[21/] has been relied upon for the actual projections of industrial growth as measured by employment and production. Special emphasis will be given to those industries, such as the pulp and paper production, having the greatest effect on the water resources of the study area.

A. Present

The historical economic development of New England and the study area follows a pattern similar to that of the United States. The availability of water power and an adequate labor force made possible the development of the textile and leather industries which gave rise to New England's primacy as an industrial center in the 19th Century. During the early part of the 20th Century the pulp and paper mills began to establish themselves, especially in the study area. In recent times, manufacturing and agriculture have claimed a declining share of the region's labor force with the service sector of the economy providing expanded levels of personal income.

Population

The basin encompasses all or parts of 2 cities, 59 towns, and 5 plantations in Maine and 1 city, 9 towns, and 14 unincorporated places in New Hampshire. The present estimated population of the basin, based on the 1960 census, has increased about 6 percent in the past 10 years and numbers 156,000 of which 136,000 are in Maine and 20,000 are in New Hampshire. The distribution of the population, as defined in the 1960 census, is 66 percent urban and 34 percent rural.

The small rural towns in the study area have followed the national trend of declining population except those towns near urban centers. These latter towns have shown slight gains in population due to the urban population's desire for more rural surroundings. The shifts in population vividly illustrate the changing economic activity from agriculture to manufacturing to services. Those urban centers with a limited economic base have not experienced any significant population increases while those fortunate enough to have developed more diversified economic bases have shown modest increases.

Mineral

Mining in the study area is small in scope and consists mainly of extracting feldspar, beryl, and mica from granite pegmatite deposits scattered throughout the middle and southern portions of the basin. The only other minerals taken on a commercial basis are clay, granite, and gravel.

Water

An abundance of water exists in the basin from the 438 miles of streams with safe yields in excess of one million gallons per day, the many miles of streams with significant yields of less than one million gallons per day and the many lakes and ponds in the region. The minimum average monthly flow at Brunswick, Maine, is about 1,143 million gallons per day. Although there are about 159 miles of streams receiving significant pollution, the quantity of water available at the present time exceeds the foreseeable water demands. At the present time, no municipal water supplies are taken from the Androscoggin River between Berlin, New Hampshire, and Merrymeeting Bay, Maine.

There are 31 existing hydroelectric plants in the basin with a total installed capacity of 161,771 kilowatts. Thirteen of these plants are operated by public utilities and develop 84,943 kilowatts with the remaining 18 plants owned by industrial concerns with a total capacity of 76,828 kilowatts. Electrical energy in the Maine portion of the basin is marketed by the Central Maine Power Company; in the New Hampshire area power is marketed by the Public Service Company of New Hampshire. Each company's transmission lines are interconnected with neighboring utilities for power exchange purposes.

Recreation

The scenic environment, numerous lakes, and cool climate attract numbers of visitors during the summer months. Abundant fish and wildlife account for considerable sportsman use during the spring and fall seasons, and the proximity to the choice New England ski slopes assures the recreational use of the area in the winter. The pollution condition of the Androscoggin and Little Androscoggin Rivers prevents their use for recreation.

The northern part of the basin offers exceptional opportunities for natural trout fishing, hunting, and camping in wilderness and semi-wilderness areas. There is an increasing demand for this type of recreation which the paper companies have acknowledged by permitting limited hunting, fishing, and camping on their timber lands.

Almost all of the land around the lakes in the northern part of the basin is owned or controlled by paper companies, except around Rangeley Lake and the eastern side of Mooselookmeguntic Lake. These two areas are slowly being developed for cottages and fishing camps; however, the remoteness and inaccessibility of the general area places a restraint on these developments.

Transportation

The transportation pattern in the basin reflects the distribution of population. The more populous southern and central portions of the basin are served by a network of highways, while the sparsely populated northern area has fewer roads. The main highways are U. S. Nos. 1, 2, I-95, and 202 and State Route Nos. 4, 5, 16, 17, and 26, and the Maine Turnpike. Freight service is provided by the Maine Central Railroad, which serves the towns in the eastern portion of the basin, the Canadian National Railroad (Grand Truck) which crosses the watershed from Portland, Maine, to Berlin, New Hampshire, and the Boston and Maine Railroad which connects Berlin with Whitefield, New Hampshire. Two commercial and one military airport and nine small airfields are located in or adjacent to the basin.

The Androscoggin River, considered a navigable stream, has not been improved for commercial navigation, other than the transportation of logs.

Agriculture

Agriculture is of minor importance to the economy of the basin except for tree production. Farms are small and scattered through the central and northern portion of the basin although predominantly a dairy area, most farms also produce poultry along with a variety of crops. Near the coast, truck farming in the sandy soil near large centers of population is the major agricultural activity.

Manufacturing

Manufacturing is of great importance to the economy of the basin with about two-thirds of the towns engaging in manufacturing to some extent. The largest of the manufacturing centers are located along the main stem of the Androscoggin River and provide employment to about 26,000 of the estimated 32,000 manufacturing workers in the basin. Over 65 percent of these 26,000 employees work in the manufacturing centers located in the lower reach of the river.

The more important manufacturing centers in the basin and their principal products are: Auburn and Lewiston with the greatest concentration of shoe and textile mills in the State, other products being electronic elements, sheet metal, printing bricks, lumber products, baking and canned foods; Berlin, pulp, paper and allied products, athletic footwear, knit goods, and foundries; Brunswick, canned foods, shoes, brushes, and lumber products; and Rumford, pulp, paper and paper products.

In the Maine section of the basin, the value of goods produced in 1962 was $295,700,000 with 21,000 workers receiving $81,188,000 in wages. This reflects an increase since 1957 of 16 percent in output, 14 percent in wages paid with practically no change in the number of wage earners. Expenditure for plant improvement in Androscoggin County, Maine, was $6.6 million in 1962, about 2¼ times the expenditure for 1957.

Other Industries

Lumbering is the only other significant industry in the basin. In 1950, cut timber having a stump value of $2 million served to meet the demands of the pulp and paper mills in the basin. There is an increasing trend of the use of hardwoods as well as soft woods; whereas, spruce and fir were harvested almost exclusively in past years.

B. Future

The geographic location of the Androscoggin River Basin with its important natural resources of water and timber in the northern part of the basin and the diversified manufacturing resources of the southern portion point to a bright economic future for the study area. The available timber resources will be adequate for sustained growth by the pulp and paper mills in the basin. A further stimulating factor in the economy will be the great demand for more recreational facilities. The Androscoggin River Basin has many undeveloped and potentially superior sites for recreation and tourism, and the future impact of recreation on the basin's economy should be significant.

Recreation

The accessibility of the northern part of the study area should be somewhat improved by the interstate highway system thereby providing opportunities for increased recreational use of the area. The Rangeley Lake Area will continue to be developed with cottages, camps, and tourists facilities; since the surrounding land is available for such development and three state highways provide access. A state park is presently under construction at Rangeley Lake, which should also help stimulate development.

Recreational development at other lakes in the area will be slower, since most of the surrounding land is owned by the paper companies; and their general policy has been to restrict such uses. However, public opinion and economic pressures are tending to alter their policies with the result that some water front lots in accessible areas are being leased to private developers. Such activity can be expected to increase in the future with the demand for such facilities increasing as more accessible areas are built up.

Projections of employment in the service industry take into account the economic impact of these recreational developments. In projecting the study area's population, future employment was used as a guide; and as a result, the projected populations reflect the additional people in the study area due to recreation.

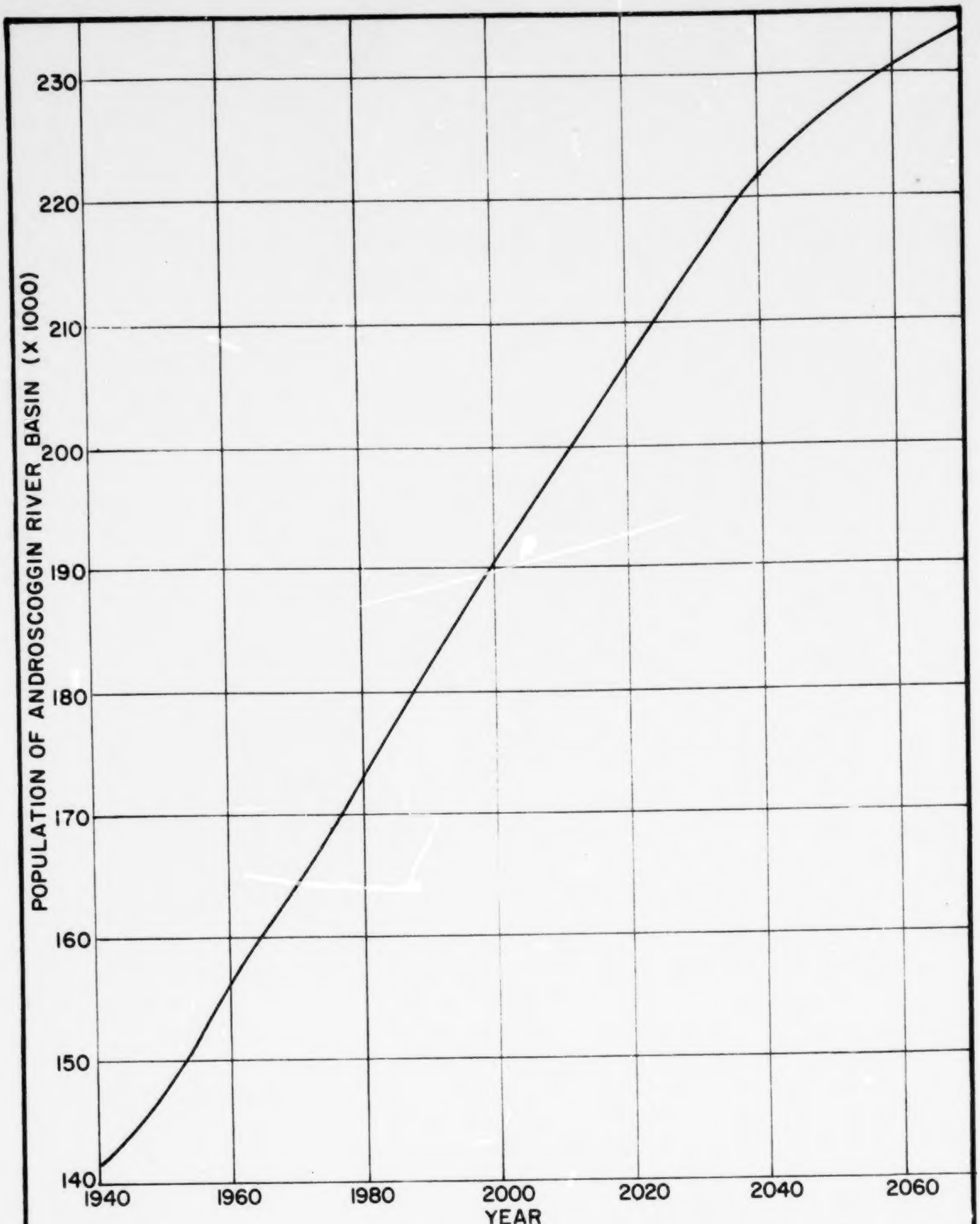
Population

The populations developed from economic and demographic studies indicate that by the year 2070, 234,000 people will inhabit the Androscoggin Basin of which 203,000 will be in Maine and the remaining 31,000 will live in New Hampshire. This projection is shown in Table 3 and illustrated in Figure V.

TABLE 3

STUDY AREA POPULATION PROJECTION

County	1940	1950	1960	1980	2000	2020	2070
Coos, New Hampshire (Subarea NH-3A)	21,020	18,770	20,180	22,000	23,900	25,800	30,900
Cumberland, Maine	3,070	3,770	6,320	9,100	11,900	14,700	18,200
Sagadahoc	1,400	1,630	2,990	3,900	5,300	6,200	7,900
Kennebec	1,300	1,240	1,240	1,300	1,300	1,400	1,600
Androscoggin	74,150	80,660	83,320	90,700	98,000	105,200	113,500
Subarea ME-2A Subtotal	79,920	87,300	93,870	105,000	116,500	127,500	141,200
Oxford	35,860	36,870	37,740	41,100	44,500	47,800	55,200
Franklin	4,840	4,670	4,580	4,900	5,200	5,600	6,400
Subarea ME-RA Subtotal	40,700	41,540	42,320	46,000	49,700	53,400	61,600
Maine Subtotal	120,620	128,840	136,190	151,000	166,200	180,900	202,800
Study Area	141,640	147,610	156,370	173,000	190,100	206,700	233,700



WATER SUPPLY AND WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN, N.H.,ME.

POPULATION PROJECTION

U.S.DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE V

The Maine portion of the Androscoggin River Basin will be considerably more urbanized than the New Hampshire portion in the future, and projections indicate a faster population growth for the southern Maine portion than for the State of Maine in general. The New Hampshire portion of the basin has historically decreased in population over the past twenty years. The population density figure of 24 persons per square mile in the New Hampshire subarea does not reflect that population is concentrated in certain areas within the subarea.[23] In the future, it is expected that urbanization will continue, but at a pace slightly slower than the rest of the State.

Employment

The Maine portion of the Androscoggin River Basin has a higher proportion of its employment in manufacturing than the State as a whole, but this differential is reducing. Projections indicate further increases in subarea ME-2A's share of the agricultural employment up to the year 1980 and a constant share thereafter. The relative increase stems from a rising demand for agricultural products in southern New England where fewer acres are cultivated each year. The employment projections by industry for the two Maine subareas are shown in Tables 4 and 5.

In the manufacturing sector, the projections indicate further declines in manufacturing employment through 1970 but some growth thereafter. The two fastest growing components will be the paper and machinery industries. Service employment is expected to grow throughout the project period; and as a result, the Maine study area total employment growth will keep pace with that of the State.

TABLE 4 [1]

EMPLOYMENT AND POPULATION IN MAINE SUBAREA Me-R, 1960-2020
(Thousands of Persons in Census of Population Equivalents)

INDUSTRY	1960	1980	2000	2020
Agriculture, Forestry and Fisheries	7.9	8.0	8.0	8.1
Agriculture[2]	5.8	5.7	5.6	5.7
Forestry[3]	0.3	0.1	0.1	0.2
Fisheries	1.8	2.2	2.2	2.2
Mining	0.2	0.3	0.3	0.3
Manufacturing	32.7	33.9	36.6	39.2
Lumber and Wood Products, except Furniture[3]	9.0	7.9	6.5	5.0
Paper and Allied Products[3]	6.2	5.6	6.7	6.8
Chemicals	0.6	0.6	0.7	1.1
Machinery and Electrical Machinery	1.2	2.8	3.6	5.0
Transportation Equipment	1.1	1.4	1.4	1.4
Other Manufacturing[4]	14.6	15.6	17.7	19.9
Service Industries[5]	46.1	56.4	75.6	100.1
TOTAL EMPLOYMENT	86.9	98.6	120.4	147.6

---

[1] Adapted from Projective Economic Studies of New England, Part III, Sub-state Areas by Arthur D. Little, Inc., for New England Division, Corps of Engineers, 1965.

[2] Based on projections furnished by U. S. Department of Agriculture, Economic Research Service.

[3] Projections and estimates of 1950 and 1960 furnished by U. S. Department of Agriculture, Forest Service.

[4] Includes: Ordnance; Food; Tobacco; Textiles; Apparel; Furniture; Printing and Publishing; Petroleum and Coal Products; Rubber and Plastics; Leather; Stone, Clay, and Glass; Primary Metals; Fabricated Metals; Instruments; and Miscellaneous Manufacturing.

[5] Includes: Contract Construction; Transportation, Communications, and Utilities; Wholesale and Retail Trade; Finance, Insurance, and Real Estate; Services; Government; and Nonclassified.

Details may not add to totals because of rounding.

TABLE 5

EMPLOYMENT AND POPULATION IN MAINE SUBAREA Me-2, 1960-2020
(Thousands of Persons in Census of Population Equivalents)

INDUSTRY	1960	1980	2000	2020
Agriculture, Forestry and Fisheries	5.7	6.1	5.8	5.8
Agriculture[2]	5.0	5.3	5.0	5.0
Forestry[3]	--	--	--	--
Fisheries	0.7	0.8	0.8	0.8
Mining	0.1	0.1	0.1	0.1
Manufacturing	60.8	61.0	69.8	75.6
Lumber and Wood Products, except Furniture[3]	3.0	1.8	1.5	1.3
Paper and Allied Products[3]	6.5	9.3	13.9	14.3
Chemicals	0.3	0.4	0.4	0.4
Machinery and Electrical Machinery	3.3	5.7	7.5	10.3
Transportation Equipment[4]	6.7	5.8	5.1	3.0
Other Manufacturing[5]	41.0	38.1	41.5	46.4
Service Industries[6]	108.9	147.9	198.0	262.4
TOTAL EMPLOYMENT	175.4	215.1	273.7	343.9

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[1] Adapted from Projective Economic Studies of New England, Part III, Sub-state Areas by Arthur D. Little, Inc., for New England Division, Corps of Engineers, 1965.

[2] Based on projections furnished by U. S. Department of Agriculture, Economic Research Service.

[3] Projections and estimates of 1950 and 1960 furnished by U. S. Department of Agriculture, Forest Service.

[4] Includes employment in government-owned facilities.

[5] Includes: Ordnance; Food; Tobacco; Textiles; Apparel; Furniture; Printing and Publishing; Petroleum and Coal Products; Rubber and Plastics; Leather; Stone, Clay, and Glass; Primary Metals; Fabricated Metals; Instruments; and Miscellaneous Manufacturing.

[6] Includes: Contract Construction; Transportation, Communications, and Utilities; Wholesale and Retail Trade; Finance, Insurance, and Real Estate; Services; Government; and Nonclassified.

Details may not add to totals because of rounding.
--Fewer than 50 persons.

In the New Hampshire portion of the Androscoggin River Basin, paper, lumber, and shoes dominate the manufacturing sector. Together, these industries employ over 75 percent of those working in manufacturing. Other important industries are leather, food, and textiles. Individual projections, as shown in Table 6, indicate that these industries will remain the primary sources of growth with a greater diversification of the manufacturing base expected to take place. Recreation and tourism are important in the New Hampshire subarea and are expected to remain an important factor in the subarea's service employment. Service employment in the New Hampshire subarea, as in all of New England, will account for a steadily increasing share of total employment.

Production

The production of pulp and paper will have the most significant effect on the water resources of the study area due to the large use of water and the problems incurred by the disposal of wastes from these two industries. The discharge of untreated wastes from the Brown Company's pulp and paper mill at Rumford, Maine, and the International Paper Company's pulp and paper mills near Livermore Falls, Maine, constitute over 95 percent of the total waste load received by the Androscoggin River above Lewiston, Maine.

In order to estimate the future waste load from the pulp and paper industry, it was necessary to project the expected pulp and paper production in the basin. It was assumed that the pulp and paper production would remain centered around the present mills and that the increases in production at each site would follow the growth rate for the respective subarea in which the present mill is located. The production projections for pulp and paper are shown in Tables 7 and 8 and illustrated in Figures A-1 and A-2 in the Appendix.

TABLE 6 [1]

EMPLOYMENT AND POPULATION IN NEW HAMPSHIRE SUBAREA NH-3, 1960-2020

(Thousands of Persons in Census of Population Equivalents)

INDUSTRY	1960	1980	2000	2020
Agriculture, Forestry and Fisheries	1.6	1.6	1.5	1.5
Agriculture [2]	1.5	1.5	1.5	1.5
Forestry [3]	0.1	0.1	--	--
Fisheries	--	--	--	--
Mining	--	--	--	--
Manufacturing	10.6	12.9	16.7	20.9
Lumber and Wood Products, except Furniture [3]	1.5	1.5	1.2	0.9
Paper and Allied Products [3]	4.3	4.5	6.4	8.2
Chemicals	0.1	0.1	0.1	0.1
Machinery and Electrical Machinery	0.7	1.3	2.0	2.9
Transportation Equipment	--	--	--	--
Other Manufacturing [4]	4.1	5.6	7.3	8.8
Service Industries [5]	19.0	25.4	40.9	63.8
TOTAL EMPLOYMENT	31.1	39.9	59.4	86.2

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[1] Adapted from Projective Economic Studies of New England, Part III, Sub-state Areas by Arthur D. Little, Inc., for New England Division, Corps of Engineers, 1965.

[2] Based on projections furnished by U. S. Department of Agriculture, Economic Research Service.

[3] Projections and estimates of 1950 and 1960 furnished by U. S. Department of Agriculture, Forest Service.

[4] Includes: Ordnance; Food; Tobacco; Textiles; Apparel; Furniture; Printing and Publishing; Petroleum and Coal Products; Rubber and Plastics; Leather; Stone, Clay and Glass; Primary Metals; Fabricated Metals; Instruments; and Miscellaneous Manufacturing.

[5] Includes: Contract Construction; Transportation, Communications, and Utilities; Wholesale and Retail Trade; Finance, Insurance, and Real Estate; Services; Government; and Nonclassified.

Details may not add to totals because of rounding
-- Fewer Than 50 Persons

TABLE 7

PROJECTIONS OF WOOD PULP PRODUCTION
(1,000 ton/year)

Area	1950	1960	1970	1980	2000	2020	2070
Maine[1]	1,183	1,666	1,960	2,280	3,180	3,580	4,580
Rural Maine (ME-R)[1]	420	494	570	670	920	1,040	N. A.
Rumford, Maine	N. A.	204[2]	235	282	372	416	525
Jay, Maine	76	96	275	339	464	528	681
New Hampshire[1]	177	N. A.[3]	250	400	700	800	1,000
Coos County (NH-3)[1]	177	N. A.[3]	250	330	575	670	N. A.
Berlin, New Hampshire	161	162	128	181	284	318	403

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[1] Figures from a report submitted by the U. S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, to Arthur D. Little, Inc., for inclusion in Projective Economic Studies in New England.

[2] 1963 Production.

[3] Not available due to the disclosure problem.

TABLE 8

PROJECTIONS OF PAPER AND PAPERBOARD PRODUCTION
(1,000 ton/year)

Area	1950	1960	1970	1980	2000	2020	2070
Maine[1]	1,328	1,806	2,250	2,680	3,570	4,700	6,000
Rural Maine (ME-R)[1]	570	673	700	810	1,040	1,380	N. A.
Rumford, Maine	N. A.	272[2]	310	364	472	612	782
Jay, Maine	103	138	242	296	407	547	712
New Hampshire[1]	263	344	410	580	750	1,400	1,760
Coos County (NH-3)[1]	183	237	280	400	630	960	N. A.
Berlin, New Hampshire	108	127	184	241	356	491	620

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[1] Figures from a report submitted by the U. S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, to Arthur D. Little, Inc., for inclusion in Projective Economic Studies in New England.

[2] 1963 Production.

VII WATER REQUIREMENTS

Because of the abundant water available in the Androscoggin River Basin, water has been used with little thought to the amount actually needed, used, or discharged; therefore, almost all data on water use in the study area consists of estimates and reasonably assumed values. The present and future water use figures given herein are based on the best information available and engineering judgment.

Present Water Use

In general, the term "water use" as used here means that amount of water which is utilized for some purpose; but it does not reflect the amount of water consumed or otherwise made unavailable for reuse. The municipalities in the study area return from 50 to 80 percent of the water used to area streams and most industries, including the pulp and paper mills, return approximately 95 percent of the water they use.

Municipal water as defined here includes residential, commercial, public, and those industrial uses which can reasonably be reflected in a per capita use figure. Also included in the per capita quantities are losses in distribution systems and treatment plants.

Industrial water, as defined in this study, refers to all water except that supplied from municipal systems which is used by the manufacturing industries and includes all water used for processing and cooling, but not that required for hydroelectric power generation.

Present and future rural water requirements were estimated for each subarea and were found to be less than 1.0 MGD in every case. This rural water requirement has not been included in the tabulations, since it is an insignificant part of the total water used within the study area.

Irrigation is not generally practiced in the basin nor is it expected to be an important use of water in the future; therefore, it was not considered in the water use study.

The most recent year for which data is available on municipal and industrial water use is 1963; therefore, it was selected as the base year for the water use study. Table 9 shows the study areas 1963 water use tabulated by type of use in each subarea and river basin. Table A-5 in the Appendix from which Table 9 was derived shows the 1963 water use of each municipality with a municipal water system and the significant water using industries within the study area.

TABLE 9

STUDY AREA'S 1963 WATER USE
(Million Gallons per Day)

Subarea	Municipal	Industrial	Total
NH-3A	3.4	58.6	62.0
ME-RA	2.8	56.4	59.2
ME-2A	10.8	13.7	24.5
Study Area Total	17.0	128.7	145.7
Androscoggin River	16.1	120.3	136.4
Little Androscoggin River	0.9	8.4	9.3

The relatively small number of municipalities and industries in the basin made it feasible to treat each of them on an individual basis and to make individual determinations of their water use.

No municipal water systems are supplied from the main stem of the Androscoggin River; however, industry relies on the river for process and cooling water and for disposal. Municipal water systems are supplied by groundwater, protected surface reservoirs, or a combination of both. Table A-5 shows the amount of ground and surface water utilized by each municipality, thus illustrating the heavy reliance by the municipal water systems on surface water supplies. Only minor amounts of groundwater are utilized by industry in the basin due to the large volumes of readily available surface water.

In the formulation of Table 9 and Table A-5, all of International Paper Company's Mills near Jay, Maine, were included in subarea ME-RA although one of the older mills is actually at Livermore Falls in subarea ME-2A. This was done because the complex of several mills along the Androscoggin River near Livermore Falls obviously operates on a unified basis, and to separate them in different economic areas would not have properly reflected the complex as it exists.

Table 9 and A-5 vividly illustrate the importance of the Androscoggin River as a source of industrial water. Table A-5 shows that pulp and paper mills account for all of the industrial water use along the main stem of the Androscoggin River in subareas NH-3A and ME-RA. In subarea ME-2A, where most of the study area's population lives, almost as much water is used for municipal purposes as for industrial uses.

Future Water Requirements

Future water requirements in the study area were estimated by combining projected unit water use rates with anticipated industrial production and population as developed in Chapter VI. In those cases where future production was not projected for a particular industry, projected employment in that industry was used as a guide in making water use projections.

Municipal: Future municipal water requirements in the study area were determined by multiplying the projected population of each community by its future per capita water use. The expected maximum and minimum per capita use figures for each subarea are shown in Table 10.

TABLE 10

PROJECTED PER CAPITA WATER USE
(Gallons per Capita per Day)

Subarea	1963		2000		2020		2070	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
NH-3A	150	80	160	100	165	110	175	115
ME-RA	130	55	150	65	160	80	165	100
ME-2A	140	75	150	100	160	110	165	125

These per capita use projections were derived by a careful analysis of past trends, socioeconomic characteristics of the subareas, prior reports, and projections by others. The projections thus obtained are considered the most reasonable conclusions that can be drawn from these sources.

Industrial: Within the study area, industrial water use is very much dependent upon the requirements of the pulp and paper industry, accounting for over 98 percent of the requirement in subareas NH-3A and ME-RA and a significant portion of the requirement in subarea ME-2A. Economic projections indicate that large increases can be expected in both pulp and paper production throughout the study area and especially in those localities where mills are presently established. Because of the large use involved, it became obvious that close attention should be paid to unit water use projections for this industry.

In an effort to determine the pulp and paper mill's present and past trends in water use, interviews were arranged with Brown Company, Oxford Paper Company, and the International Paper Company. During these discussions, it was found that these three companies take in process water and discharge waste water with only partial measurement made of the amounts involved. Each company did make estimates of the total water used per day and the volume of water treated each day. Estimates of waste discharge volumes were obtained from the respective State Water Pollution Control Agencies for all three mills. Table 11 shows the unit water use values estimated for each company's production of Kraft pulp and specialty papers. These are representative figures and do not include water for groundwood pulp and paper, nor for bleached pulp. The large discrepancies between companies are rather noticeable and can be attributed to (1) the heavy reliance placed on present unit water use values in making the projections and (2) the availability of better quality water to the Brown Company so that it does not have to treat its water to the same degree as the two downstream companies. The reduction of unit water use within time is based on anticipated recirculation and other water conservation practices, which will be employed to reduce the costs involved in developing adequate waste treatment facilities.

TABLE 11

PROJECTED UNIT WATER USE FOR PULP AND PAPER MANUFACTURE
(Gallon per Ton of Production)

Mill	Product	1963	2000	2020	2070
Brown Company	Pulp	77,500	70,000	65,000	50,000
	Paper	45,500	39,000	37,000	35,000
Oxford Paper	Pulp	38,400	35,000	35,000	30,000
	Paper	20,100	18,000	15,000	15,000
International	Pulp	N. A.	13,000	12,500	12,000
	Paper	15,000	22,000	20,000	15,000

The study area's future municipal and industrial water requirements by year for each subarea and river basin are shown in Table 12. A more detailed breakdown of these figures is included in Tables A-6 through A-8 in the Appendix.

Water Storage Requirements

The present flow of the Androscoggin River of 1,000 MGD, which may be expected 98 percent of the time at Rumford, Maine, (RM86.0) is adequate to meet all present and anticipated future municipal and industrial water requirements in the study area. The maximum municipal and industrial water requirements in the year 2070 of 206 MGD for subarea NH-3A can easily be met by the flow in the Androscoggin River.

TABLE 12

SUMMARY OF STUDY AREA'S FUTURE WATER REQUIREMENTS
(Million Gallons per Day)

Subarea	Municipal	Industrial	Total
For the Year 2000			
NH-3A	4.2	160.0	164.2
ME-RA	3.8	135.3	139.1
ME-2A	15.1	26.4	41.5
Study Area Total	23.1	321.7	344.8
Androscoggin River	21.6	305.6	327.2
Little Androscoggin River	1.5	16.1	17.6
For the Year 2020			
NH-3A	4.5	178.0	182.5
ME-RA	4.6	153.4	158.0
ME-2A	18.9	32.7	51.6
Study Area Total	28.0	364.1	392.1
Androscoggin River	26.1	344.1	370.2
Little Androscoggin River	1.9	20.0	21.9
For the Year 2070			
NH-3A	5.7	200.0	205.7
ME-RA	6.6	175.7	182.3
ME-2A	25.2	40.8	66.0
Study Area Total	37.5	416.5	454.0
Androscoggin River	34.9	391.5	426.4
Little Androscoggin River	2.6	25.0	27.6

No decrease in the river's low flow is anticipated. No need for additional storage on the mainstem of the Androscoggin River for municipal or industrial water supply purposes is anticipated.

The present water quality of the Androscoggin River is rather poor for municipal water supply due to taste and odor causing organics; however, the quantity is ample and with proper treatment, the river's water could be suitable for all municipal purposes. With adequate control of waste discharges and reasonable pretreatment, only industries requiring the very highest water quality, such as beer brewing, would find the Androscoggin River unsuitable for use due to quality.

A need may exist by the year 2000 in the Little Androscoggin River Basin for local water storage projects yielding up to 8 MGD for industrial water supply; however, it would not be feasible to provide such storage in the proposed Pontook Project. Any such needs in the Little Androscoggin River Basin should be more fully determined and defined by the proposed New England Comprehensive Water Pollution Control Program.

VIII WATER QUALITY CONTROL

Water quality control is defined as any measure employed to enhance the utility, value, and attractiveness of waters used for purposes which are affected by changes in water quality. Waters in nature are never PURE in the strict chemical sense of the word. More often than not, however, natural waters are fit for use by man in his pursuit of normal endeavors. This use and subsequent return of waste almost always causes some degradation of water quality downstream, even after provision of secondary waste treatment. As population and the associated demand for water increase, this degradation of the water resource increases. Water quality should first be controlled at the waste source by providing the best available treatment. When additional steps must be taken to maintain water quality, treatment may be supplemented by providing additional streamflow. This report is concerned with the possible inclusion of storage in the proposed Pontook reservoir for the regulation of streamflow for water quality control.

Municipal and Industrial Pollution

The determination of the quantity and quality of return flows expected to reach a stream is the first step necessary in analyzing flow regulation needs for water quality control. The quantity of municipal and industrial return flows is estimated as a percentage of water use. The return flows estimated for the municipalities varied from 50 to 80 percent of water use. Except for the pulp and paper industry, only limited information is available on the return flow percentages for the industries in the study area. The pulp and paper mills return approximately 95 percent of the water taken in. Considering the limited water use, this was also adopted as the return flow for the other industries in the study area.

The quality of the municipal return flows before waste treatment is based on present and anticipated per capita contributions of oxygen consuming wastes as measured by the ultimate first-stage biochemical oxygen demand (BOD). In order to take into account the pollutional effect of increased urban runoff with population growth, increasing per capita contributions with time were selected. The selected values also reflect an anticipated increase in the per capita contribution as a result of the increasing use of individual garbage disposal units, automatic washers, and the extension of municipal sewerage facilities to industrial firms within the municipalities. The per capita contribution of ultimate first-stage BOD selected for 1960 is 0.25 lb. BOD/cap/day, for 2000 and 2020 it is 0.35 lb. BOD/cap/day, and for 2070 it is 0.40 lb. BOD/cap/day.

It has been assumed in this study that the actual amount of pollutional material reaching the Androscoggin River from municipal sources would be reduced by secondary waste treatment. The percentage reduction in BOD due to secondary treatment varies from a low of 65 percent for poorly operated waste treatment plants to a high of 95 percent for well operated, modern plants.

For the year 2000, a BOD reduction of 70 percent was considered reasonable, since not all communities are expected to have adequate waste treatment plants operating by this time. An effective BOD reduction of 85 percent was used for the years 2020 and 2070, since all the communities in the study area are expected to have secondary waste treatment plants operating by this time. For communities in the study area, it is not considered reasonable to base design of streamflow regulation facilities on a BOD reduction greater than 85 percent because of occasional sewage bypassing during storms, equipment failure, possible operating problems, and contributions from urban runoff.

The quality of the industrial return flows before waste treatment are based on calculated and estimated contributions of oxygen consuming wastes per quantity of product produced and an appraisal of the effects of inplant control measures that can be expected. The actual values used were usually determined in terms of the 5-day, 20°C. BOD per ton of product which was converted to an ultimate, first-stage BOD by using a reaction rate (K_1) furnished by the Maine Water Improvement Commission for each waste.

A summary of 1964 waste loads and return flows is shown in Tables 13 and 14 with the complete inventory of all waste sources from which these tables were derived shown in Table A-9 of the Appendix. These are the waste loads, the dissolved oxygen, and BOD curves previously shown in Figures III and IV. A review of the complete inventory indicates that the three pulp and paper mills along the main stem of the Androscoggin River are the major contributors of organic

TABLE 13

STUDY AREA'S 1964 WASTE LOADS
(Population Equivalents)

SUBAREA	MUNICIPAL	INDUSTRIAL	TOTAL
NH-3A	17,500	325,000	342,500
ME-RA	29,010	676,400	705,410
ME-2A	75,630	133,720	209,350
Study Area Total	122,140	1,135,120	1,257,260
Androscoggin River	112,600	1,014,400	1,127,000
Little Androscoggin River	9,540	120,720	130,260

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*Based on 0.17 lb. 5-day BOD per capita.

TABLE 14

STUDY AREA'S 1964 RETURN FLOWS
(Million Gallons Per Day)

SUBAREA	MUNICIPAL	INDUSTRIAL	TOTAL
NH-3A	1.88	55.6	57.48
ME-RA	1.86	53.55	55.41
ME-2A	7.75	13.05	20.80
Study Area Total	11.49	122.20	133.69
Androscoggin River	10.94	114.22	125.16
Little Androscoggin River	0.55	7.98	8.53

wastes. Unit waste loads from these mills ranged from a low of 10 lbs. 5-day BOD per ton of groundwood to a high of 510 lbs. 5-day BOD per ton of sulfite pulp.

The projected production of pulp and paper determined in Chapter VI for each mill's area was multiplied by the corresponding projected unit waste load to obtain the total pollutional load from each area. Representative unit waste loads for Kraft pulp and specialty papers are shown in Table 15 for each mill. These unit waste loads do not reflect the wastes from groundwood pulp nor from bleached pulp production. The decreasing unit waste loads with time are expected as a result of efforts by each company to reduce the costs involved in developing adequate waste treatment facilities.

TABLE 15

PROJECTED UNIT WASTE LOADS FOR PULP AND PAPER
(Lbs. 5-Day BOD per Ton Production)

Mill	Product	2000	2020	2070
Brown Company	Pulp	60	60	60
	Paper	20	20	20
Oxford Paper	Pulp	35	35	30
	Paper	18	15	15
International	Pulp	50	50	50
	Paper	25	23	20

For the purposes of this study, all industrial waste discharges containing BOD were considered to be subjected to secondary treatment by the year 2000. Flow regulation needs are based on the conclusion that, on the average, 85 percent of the BOD would be removed from these industrial wastes.

A summary of the study area's projected waste loads after adequate treatment and return flows is shown in Tables 16 and 17, according to subareas and river basins. Tables A-10 through A-12 in the Appendix, from which Tables 16 and 17 were developed, show the projected waste loads and return flows for each waste source in the study area.

Since rural water use and irrigation were found to be insignificant in the study area, no return flows or waste loads were assumed for these two water uses. The various cottages and camps aroung Rangeley and other area lakes were treated as rural water users since at present their waste discharges do not have any significant effect on the water quality of the lakes. In the future, if these camps and cottages continue some of their present practices of using inadequate septic tanks and the discharge of untreated wastes to the lakes, problems of water quality could develop. The solution to such problems would of course be collection and treatment of these wastes. Even after waste treatment, problems of nutrient buildup with corresponding nuisance growths of aquatic plants could occur. Such problems should be given considerable consideration as the area develops and waste treatment facilities are planned and designed.

The uncontrolled runoff from the drainage area was assumed to contain 1.5 milligrams per liter (mg/l) of ultimate, first-stage BOD. This is a minor waste load, since the uncontrolled runoff was less than 400 cfs between any two major waste sources.

TABLE 16

SUMMARY OF STUDY AREA'S FUTURE WASTE LOADS
(Population Equivalent)

Subarea	Municipal	Industrial	Total
For the Year 2000 (P. E. Based on 0.24 lb. 5-Day BOD Per Capita)			
NH-3A	7,050	50,000	57,050
ME-RA	11,970	145,920	157,890
ME-2A	34,200	23,980	58,180
Study Area Total	53,220	219,900	273,120
Androscoggin River	48,900	197,610	246,510
Little Androscoggin River	4,320	22,290	26,610
For the Year 2020 (P. E. Based on 0.24 lb. 5-Day BOD Per Capita)			
NH-3A	3,900	57,000	60,900
ME-RA	6,600	169,330	175,930
ME-2A	20,120	30,630	50,750
Study Area Total	30,620	256,960	287,580
Androscoggin River	28,140	229,360	257,500
Little Androscoggin River	2,480	27,600	30,080
For the Year 2070 (P. E. Based on 0.27 lb. 5-Day BOD Per Capita)			
NH-3A	4,800	63,500	68,300
ME-RA	7,870	170,680	178,550
ME-2A	24,690	34,020	58,710
Study Area Total	37,360	268,200	305,560
Androscoggin River	34,280	237,510	271,790
Little Androscoggin River	3,080	30,690	33,770

TABLE 17
SUMMARY OF STUDY AREA'S FUTURE RETURN FLOWS
(Million Gallons Per Day)

Subarea	Municipal	Industrial	Total
For the Year 2000			
NH-3A	2.5	152.0	154.5
ME-RA	2.6	128.2	130.8
ME-2A	10.9	25.1	36.0
Study Area Total	16.0	305.3	321.3
Androscoggin River	15.1	289.8	304.9
Little Androscoggin River	0.9	15.5	16.4
For the Year 2020			
NH-3A	2.9	170.0	172.9
ME-RA	3.2	149.1	152.3
ME-2A	13.8	31.0	44.8
Study Area Total	19.9	350.1	370.0
Androscoggin River	18.6	331.1	349.7
Little Androscoggin River	1.3	19.0	20.3
For the Year 2070			
NH-3A	4.0	191.0	195.0
ME-RA	4.7	168.4	173.1
ME-2A	21.3	38.8	60.1
Study Area Total	30.[illegible]	398.2	428.2
Androscoggin River	28.2	374.5	402.7
Little Androscoggin River	1.8	23.7	25.5

Water Quality Objectives

Of the indicators presently available as a measure of water quality, dissolved oxygen was chosen for use in this study. The Androscoggin River's low total dissolved solids make solids noncritical. The principal cause of pollution in the Androscoggin River Basin is the discharge of oxygen consuming wastes by the pulp and paper industry, a large variety of other industrial firms, and municipalities. These wastes are presently discharged without the benefit of treatment and seriously deplete the oxygen resources of the river. This has been discussed in Chapter V.

Dissolved oxygen was chosen as the basis for water quality control, since an adequate supply is necessary for all normal in-stream uses such as recreation, fish and aquatic life habitat, and maintenance of a satisfactory quality from a taste and odor standpoint for use as a source of municipal water supply. In selecting dissolved oxygen as the indicator of quality, the following assumptions were made: (1) all municipal sewage should be disinfected to a level so that bacteria populations would not be a problem; and (2) wastes producing undesirable levels of color in the river would be treated prior to discharge so that color would not be a problem.

Water to regulate quality was considered to be needed when the dissolved oxygen content of the stream dropped below 5 mg/l. The lower limit of 5 mg/l of dissolved oxygen was selected, since (1) it provides an acceptable environment for most aquatic life native to the Androscoggin River; and (2) it provides a buffer zone for assimilating unforeseen spills of waste that occasionally occur.

Water Quality Calculations

Streamflow regulation for water quality control is accomplished by the inclusion of additional storage so that flows can be released to augment low flows that can reasonably be expected to occur in the stream. In the case of the main stem of the Androscoggin River, discharge and runoff frequency analyses of available U. S. Geological Survey streamflow data were made and are shown as Figures I and II in Chapter V. Calculations were then performed to determine the amount of water to be released from storage to maintain a dissolved oxygen content of 5 mg/l in the stream. These calculations were performed for hydrologic conditions that can be expected to recur in the river on the average about once in every 20 years, every ten years, and every five years.

The analyses of the Androscoggin River's water quality after all wastes have received adequate waste treatment for the years 2020 and 2070 were made with the aid of an electronic computer. These studies were made for the Androscoggin River from Berlin, New Hampshire, (RM 137.0) to Lewiston, Maine, (RM 30.8) by constructing a mathematical model of the river which reflected the waste assimilative capacity of each different river section and all withdrawals and inflows to the river. The calculations of waste assimilative capacity were based on the well known Streeter-Phelps equation for the Oxygen-Sag Curve with special attention paid to the determination of the rate constants of deoxygenation (K_1) and reaeration (K_2) needed for this equation.11/

The data used in these calculations was obtained from river samples collected and analyzed by the Maine Water Improvement Commission and the New Hampshire Water Pollution Commission.[25] [30] The points where samples were collected are shown in Table A-4, and the values used for K_1 and K_2 are shown in Table A-13 of the Appendix.

A lack of sufficient data prevented the formulation of a mathematical model for the river below Lewiston, Maine. Under the present adverse conditions of untreated industrial waste discharges, the last 30 miles of the Androscoggin River below Lewiston has at lease 5.0 mg/l of dissolved oxygen. Since the future treated waste discharges below Lewiston will be less than present waste loads, it is concluded that the Androscoggin River below Lewiston will have at least 5.0 mg/l of dissolved oxygen through the year 2070.

Flow Regulation

Figures A-3 through A-7 show the smoothed curves of dissolved oxygen as plotted by the computer for the treated waste loads anticipated in the years 2020 and 2070. Calculations were also made for an industrial waste load of twice the 2070 waste load. This was done as a check on the sensitivity of the mathematical model to waste loadings and to see the effect of unanticipated production increases. An examination of the plotted curves indicates that the only time the dissolved oxygen goes below 5.0 mg/l is for the Double 2070 waste load at a flow frequency of 95 percent.

The various curves show that the mathematical model responded as expected to increases in waste load, river flow, and temperature.

For design purposes, a temperature of 25°C, a flow frequency of 95 percent, and the 2070 waste load was selected. Figures A-4 and A-7 show that for these conditions the dissolved oxygen concentration in the Androscoggin River from Berlin, New Hampshire, to Lewiston, Maine, can be expected to be above 6.0 mg/l.

No water storage is needed now nor is it anticipated that it will be needed in the future for water quality control of the Androscoggin River. This conclusion is based on the treatment of all waste discharges by the year 2020 by secondary processes.

If future waste loadings should ever approach twice the projected 2070 industrial load, consideration should be given to flow regulation as a means of maintaining 5.0 mg/l of dissolved oxygen in the Androscoggin River.

Since regulation by Pontook Reservoir would not be available for control of quality in the Little Androscoggin River, sufficient information to adequately define the water quality control needs of the Little Androscoggin River was not assembled at this time. The need for flow regulation for water quality control of this river should be investigated during the proposed New England Comprehensive Water Pollution Control Project studies.

IX BENEFITS

No present or future need has been found on the Androscoggin River for additional storage in the proposed Pontook Project for either municipal and industrial water supply or for regulation of streamflow for water quality control. Since available controlled flows are ample to meet anticipated needs, no benefits can be assigned to the Pontook Project for water storage for water supply or water quality control purposes.

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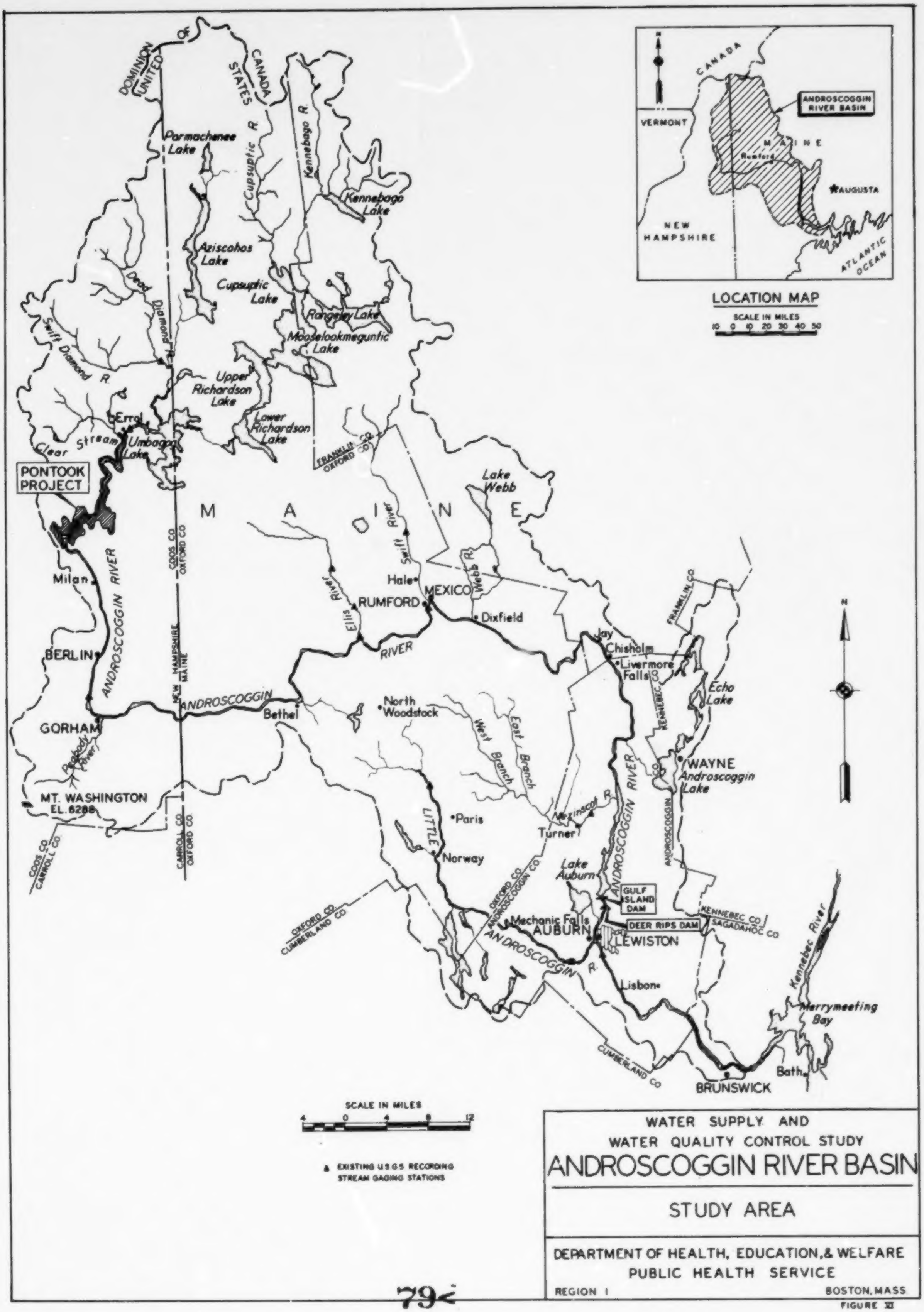

DOMINION OF CANADA
UNITED STATES
Parmachenee Lake
Cupsuptic R.
Kennebago R.
Kennebago Lake
Aziscohos Lake
Cupsuptic Lake
Rangeley Lake
Mooselookmeguntic Lake
Dead Diamond R.
Swift Diamond R.
Upper Richardson Lake
Lower Richardson Lake
Errol
Clear Stream
Umbagog Lake
PONTOOK PROJECT
FRANKLIN CO
OXFORD CO
Lake Webb
M A I N E
COOS CO
OXFORD CO
Swift River
Webb R.
Milan
ANDROSCOGGIN RIVER
Hale
MEXICO
RUMFORD
Dixfield
Ellis River
BERLIN
NEW HAMPSHIRE
MAINE
RIVER
Jay
Chisholm
Livermore Falls
FRANKLIN CO
KENNEBEC CO
Echo Lake
ANDROSCOGGIN
Bethel
North Woodstock
West Branch
East Branch
GORHAM
Peabody River
WAYNE
Androscoggin Lake
MT. WASHINGTON
EL. 6288
COOS CO
CARROLL CO
CARROLL CO
OXFORD CO
LITTLE
Paris
Nezinscot R.
Turner
Norway
ANDROSCOGGIN RIVER
ANDROSCOGGIN CO
Lake Auburn
OXFORD CO
ANDROSCOGGIN CO
GULF ISLAND DAM
DEER RIPS DAM
KENNEBEC CO
SAGADAHOC CO
OXFORD CO
CUMBERLAND CO
Mechanic Falls
AUBURN
LEWISTON
ANDROSCOGGIN R.
Lisbon
Kennebec River
Merrymeeting Bay
CUMBERLAND CO
Bath
BRUNSWICK
N
CANADA
VERMONT
ANDROSCOGGIN RIVER BASIN
MAINE
Rumford
AUGUSTA
NEW HAMPSHIRE
ATLANTIC OCEAN
LOCATION MAP
SCALE IN MILES
10 0 10 20 30 40 50
SCALE IN MILES
4 0 4 8 12
▲ EXISTING U.S.G.S RECORDING STREAM GAGING STATIONS

WATER SUPPLY AND
WATER QUALITY CONTROL STUDY

ANDROSCOGGIN RIVER BASIN

STUDY AREA

DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE

REGION I BOSTON, MASS

FIGURE XI

APPENDIX

TABLE A-1

CHARACTERISTICS OF SUBAREA NH-3 23/

Sub-Area	Counties	County in Study Area	Towns in Study Area	1960 Population in Study Area	Population Class	Economy	Topography
NH-3	Coos Grafton	Coos	Beans Purchase, Greens Grant, Martins Location, Pinkhams Grant, Thompson & Meserve Purchase, Low & Burbanks Grant, Randolph, Gorham, Shelburne, Berlin, Milan, Success Twp., Cambridge Twp., Dummer, Errol, Millsfield Twp., Wentworths Location, Dixville Twp., Dixs Grant, Second College Grant Atkinson & Gilmanton, Aqademy Grant, Clarksville, Pittsburg	20,181	77% Urban concentrated in Berlin	Pulp & Paper, Textiles, Recreation, Services	Forested, Mountainous, Rugged

TABLE A-2

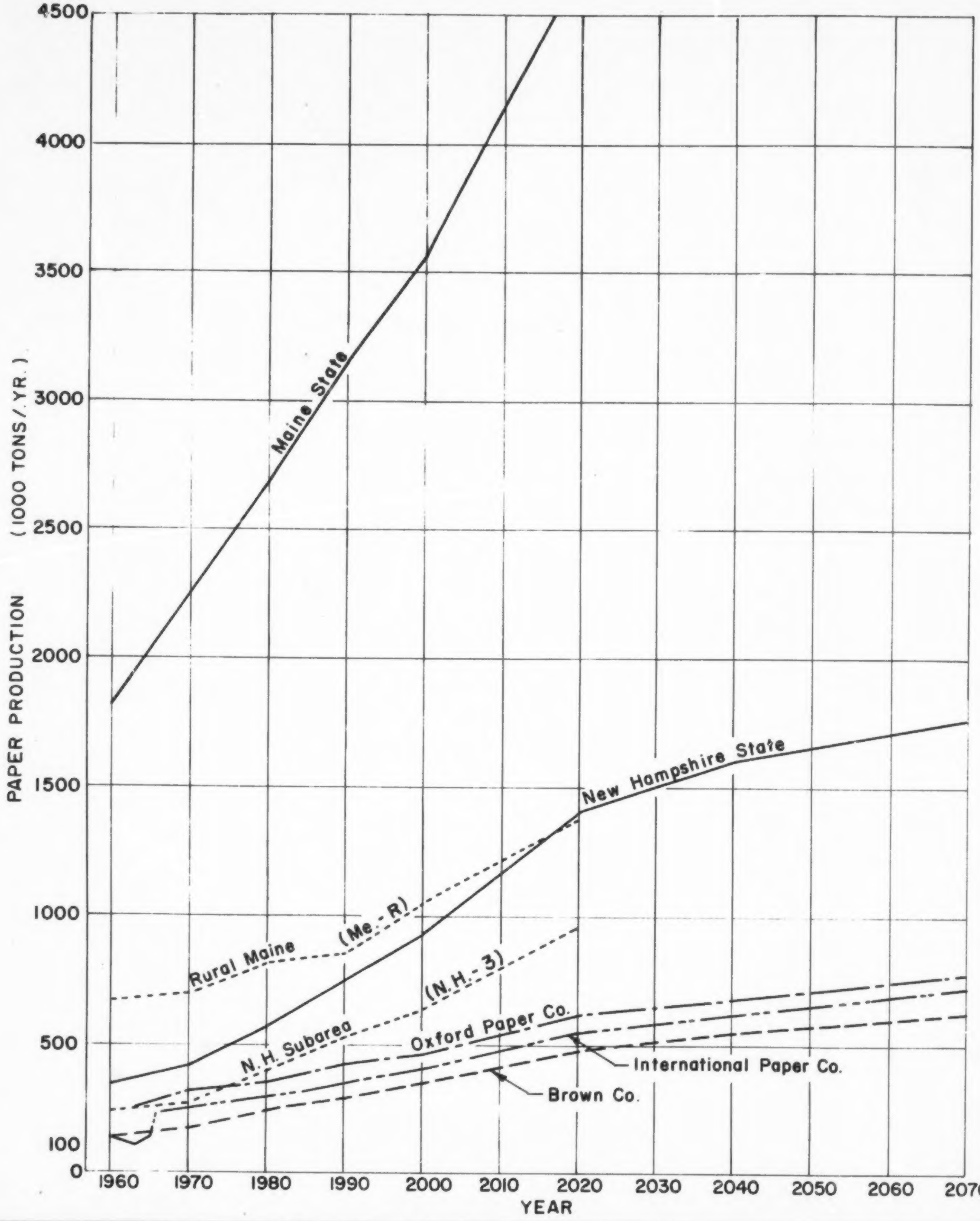
CHARACTERISTICS OF SUBAREA ME-2 23/

Sub-Area	Counties	County in Study Area	Towns in Study Area	1960 Population in Study Area	Population Class	Economy	Topography
ME-2	Androscoggin Kennebec Sagadahoc Cumberland York	Androscoggin	Durham, Lisbon, Webster, Wales, Leeds, Livermore, Livermore Falls, Turner, Greene, Minot, Mechanic Falls, Poland, Lewiston, Auburn	83,318	82% Urban concentrated in Lewiston and Auburn	Pulp & Paper, Textiles, Leather, Food	Rolling
		Kennebec	Wayne, Fayette, Mt. Vernon, Vienna, Monmouth	1,240	Rural	Agriculture	Hilly Forested
		Sagadahoc	Topsham, Bowdoin	2,986	Rural	Paper, Agriculture	Rolling
		Cumberland	Brunswick, Raymond, Casco, Otisfield, New Gloucester	6,324	83% Urban concentrated in Brunswick	Paper, Textiles, Agriculture	Rolling

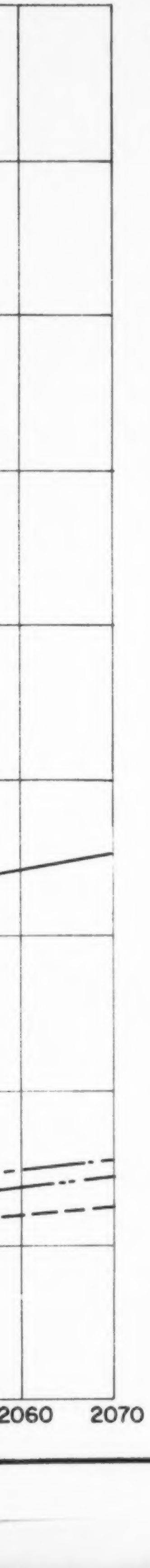
TABLE A-3

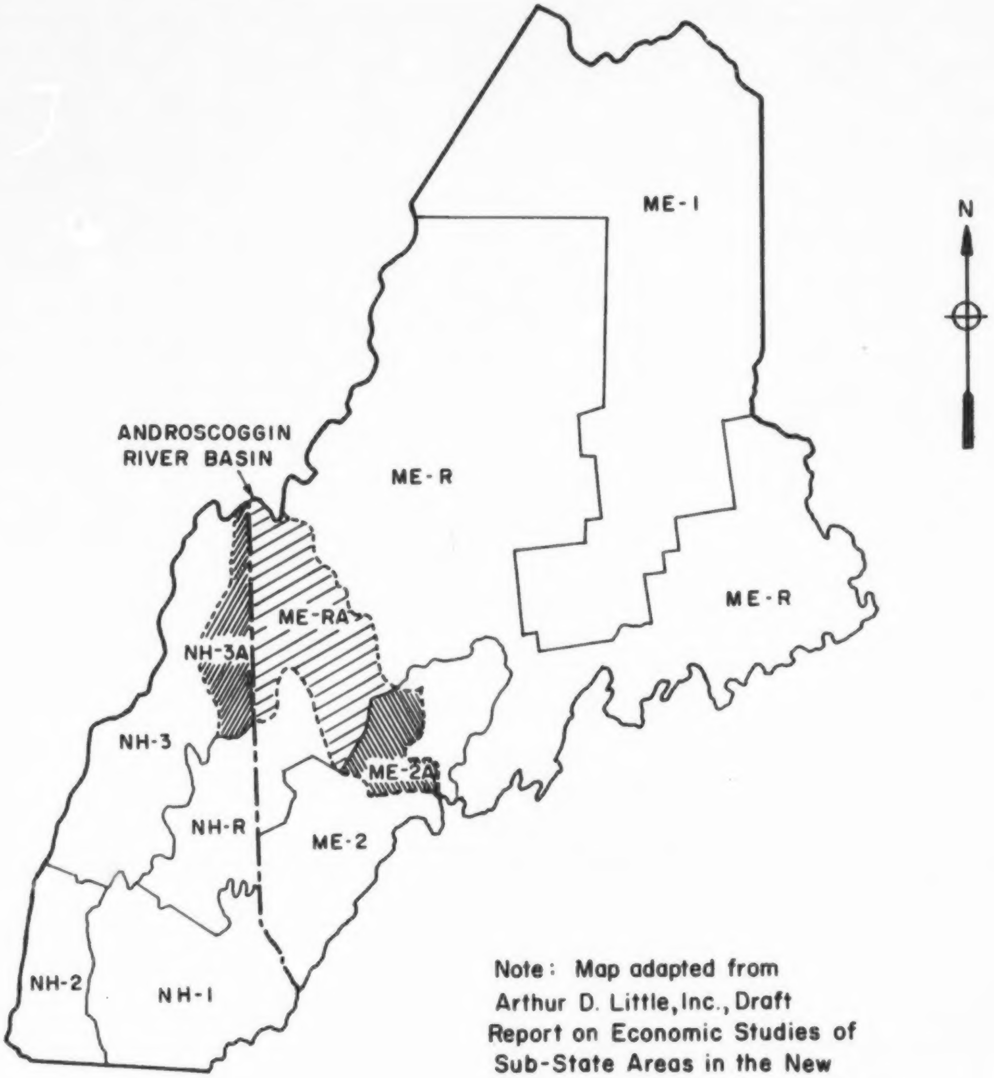
CHARACTERISTICS OF SUBAREA ME-R 23/

Sub-Area	Counties	County in Study Area	Towns in Study Area	1960 Population in Study Area	Population Class	Economy	Topography
ME-R	Oxford, Franklin, Somerset, Piscataquis, Waldo, Lincoln, Knox, Hancock, Washington	Oxford	Oxford, Hebron, Buckfield, Hartford, Canton, Dixfield, Mexico, Rumford, Roxbury, Byron, Andover, Upton, Magalloway Place, Lincoln, Newry, Gilead, Bethel, Hanover, Greenwood, Peru, Woodstock, Sumner, West Paris, Paris, Norway, Unorganized Territory	37,743	37% Urban concentrated in Rumford, Mexico, & Norway	Pulp & Paper, Lumber & Wood Products, Leather, Textiles	Rocky Upland, Hilly, Forested
		Franklin	Chesterville, Jay, Wilton, Carthage, Temple, Weld, Rangeley, Sandy River, Plantation, Dallas Plantation, Unorganized Territory	4,580	Rural	Pulp & Paper, Agriculture	Rocky Upland, Hilly, Forested



PAPER PRODUCTION (1000 TONS/YR.)
4500
4000
3500
3000
2500
2000
1500
1000
500
100
0
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
YEAR
Maine State
New Hampshire State
Rural Maine (Me. R)
N.H. Subarea (N.H. 3)
Oxford Paper Co.
International Paper Co.
Brown Co.




ME-I
N
ANDROSCOGGIN RIVER BASIN
ME-R
ME-R
ME-RA
NH-3A
NH-3
ME-2A
NH-R
ME-2
NH-2
NH-I

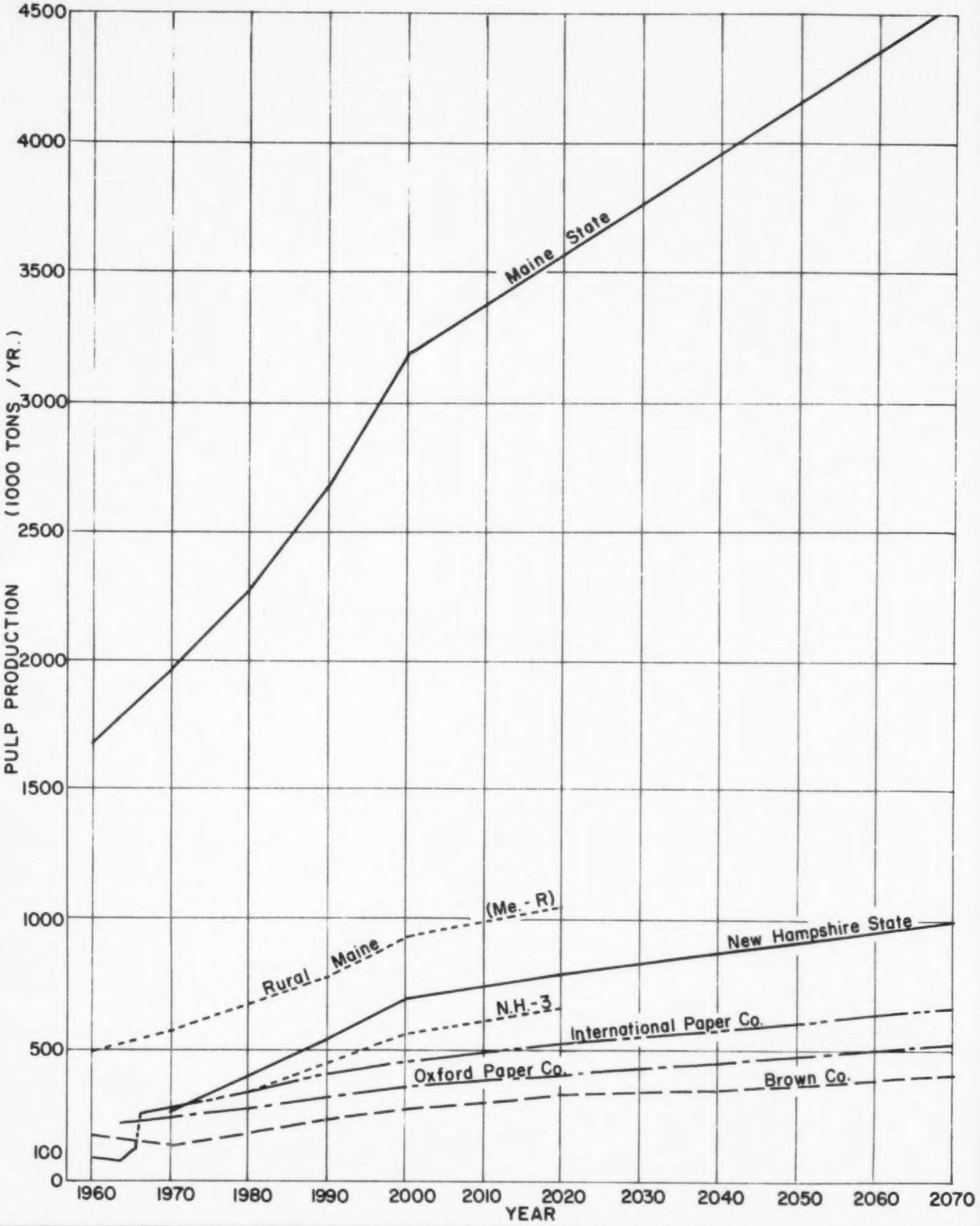
Note: Map adapted from Arthur D. Little, Inc., Draft Report on Economic Studies of Sub-State Areas in the New England States. Data for area and subarea curves from U.S. Forest Service.

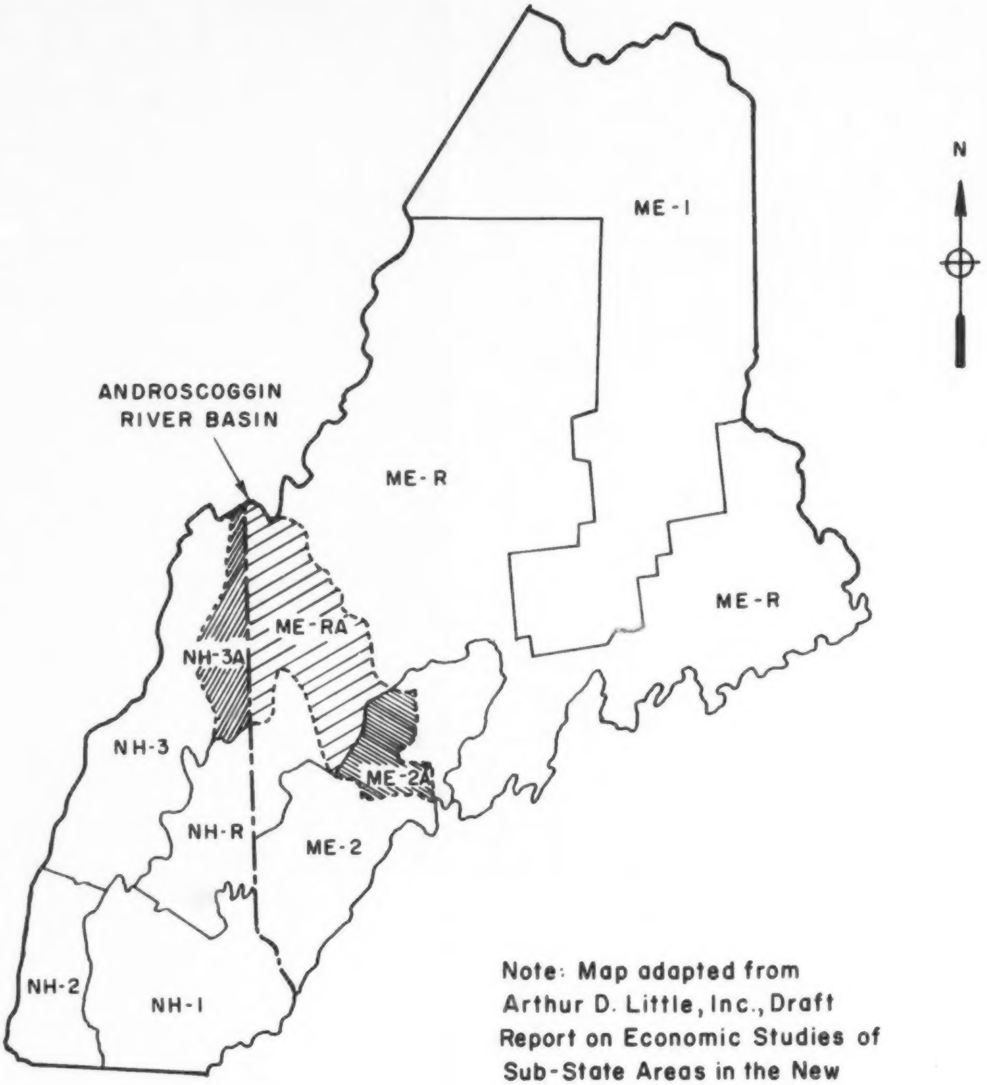
WATER SUPPLY AND WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN, N.H., ME.

PROJECTIONS OF PAPER PRODUCTION

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE A-I


PULP PRODUCTION (1000 TONS / YR.)
4500
4000
3500
3000
2500
2000
1500
1000
500
100
0
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
YEAR
Maine State
(Me. - R)
Rural Maine
New Hampshire State
N.H. - 3
International Paper Co.
Oxford Paper Co.
Brown Co.


N
ANDROSCOGGIN RIVER BASIN
ME-I
ME-R
ME-R
ME-RA
NH-3A
NH-3
ME-2A
NH-R
ME-2
NH-2
NH-I

Note: Map adapted from Arthur D. Little, Inc., Draft Report on Economic Studies of Sub-State Areas in the New England States. Data for area and subarea curves from U.S. Forest Service.

WATER SUPPLY AND WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN, N.H., ME.

PROJECTIONS OF PULP PRODUCTION

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE A-2

TABLE A-4

ANDROSCOGGIN RIVER

IMPORTANT POINTS ON RIVER

River Mile	Maine W.I.C.. Sample Station No.	Point	Comment
169.1		Dam - Errol	Top El. 1,245.0
168.6		USGS Gagin Station @ Errol	
168.2		Clear Stream	
151.3		Old Pontook Storage Dam	
149.0		New Pontook C. E. Dam	
138.8	1-N.H.	Bells Icehouse	
138.2		Dam - Brown Co. (Sawmill)	Top El. 1,094.1
137.8		Dam - Brown Co., Riverside Sta.	Top El. 1,077.3
137.1		Dam - Pub. Ser. N.H., - Smith Sta.	Top El. 1,010.0
137.0		Brown and Berlin Sewage Discharge	
136.8		Dead River @ Berlin	
136.1		Dam - Brown Co., Cross Power	Top El. 922.0
135.6		Dam - Brown Co., Cascade Mill	Top El. 901.0
135.5		Cascade Mill - Brown Co.	
134.4		USGS Gaging Sta., Gorham	
132.6		Dam - Brown Co., Gorham Sta.	Top El. 814.5
131.6		Moose River	
130.4	2-N.H.	Dam - Pub. Ser., N.H., Gorham Sta.	Top El. 773.0
129.9		Peabody River @ Gorham	
127.6		Dam	Top El. 725.2

River Mile	Maine W.I.C. Sample Station No.	Point	Comment
124.8		Cement Brook @ Shelburne	
121.8		N.H. - ME. State Line	
120.8		Ingalls River @ Riley	
119.6		Wild River @ Gilead	
119.2	1	Bridge @ Gilead	
114.0		Pleasant River @ W. Bethel	
109.4	2	U. S. Rte. 2 Bridge @ Bethel	
109.0		Alder River	
108.0		Twitchell Brook @ Mayville	
105.7		Sunday River @ N. Bethel	
103.5		Bear River @ Newry	
97.1		Ellis River @ Hanover	
96.8	3	Rte. 232 Bridge @ Rumford Point	
95.0		Concord River	
88.0		Logan Brook	
87.6	4	Virginia Bridge	
87.5		USGS Gaging Sta. - Rumford	
87.5		Dam - Rumford Falls Power	Top El. 600.8
87.1		Dam - Rumford Falls	Top El. 500.2
87.0	5	Oxford Canal Gates	
86.3		Swift River @ Mexico	
86.0		Oxford Paper & Rumford Sewage Discharge	
86.0		Mexico Sewage Discharge	
82.0	7	Rte. 108 Bridge @ Dixfield	

River Mile	Maine W.I.C. Sample Station No.	Point	Comment
81.8		Webb River @ Dixfield	
78.6	7-8	Newton Brook @ Peru	
76.3		Worthley Brook @ East Peru	
74.8	8-8	Supplemental Sample Station	
71.7	8	Rte. 140 Bridge @ Canton (Gilbertville)	
71.4		Whitney Brook @ Canton & Gilbertville	
66.6	9	Dam - International Paper, Riley	Top El. 373.0
64.7		New International Pulp Mill	
63.8	10	Dam - International Paper, Jay	Top El. 353.4
61.8	11	Dam - International Paper, Otis Mill @ Chisholm	Top El. 339.5
60.9		Dam - International Paper, Livermore Falls	Top El. 312.6
53.2	11-12	East Livermore @ Strickland Ferry	
52.0		Dead River	
49.0	12	Rte. 108 Bridge @ North Turner	
44.9		Nezinscot River & Keens Mills	
44.6		Allen Stream @ West Leeds	
42.6	13	Turner Center Bridge To Greene	
34.8	14	Dam - Gulf Island, Cent. Me. Power	Top El. 262.0
33.7	15	Dam - Deer Rips, Cent. Me. Power	Top El. 205.7
32.3		Bobbin Mills Brook from Lake Auburn	
30.8	16	Dam - Union Water Power Company	Top El. 167.7
30.1		Confluence Little Androscoggin River	

River Mile	Maine W.I.C. Sample Station No.	Point	Comment
28.8		Lesiston-Auburn Sewage Discharge	
28.4		USGS Auburn Gaging Sta.	
28.0	18	Interstate 95 Bridge	
21.2	18-19	Above Island near SW Bend	
17.7		Sabattus River - Lisbon Center	
16.0	19	Dam - Worumbo Manufacturing Co.	Top El. 96.3
15.8	20	Rte. 19 Bridge Lisbon Falls	
15.7		Dam - U. S. Gypsum Company	Top El. 77.6
15.5		Meadow Brook - Durham	
15.4		Little River	
12.7	21	Dam - Pejepscot Paper Co.	Top El. 63.7
8.4	22	Foot Bridge - Topsham	
8.2		Dam - Verney Mills	Top El. 40.1
8.0		Dam - Cent. Me. Power - Tidewater @ Toe	Top El. 18.8
8.0	23	Rte. 201 Bridge @ Brunswick	
0.0		Brick Island - End of Androscoggin River	

TABLE A-5

YEAR 1963 WATER REQUIREMENTS OF STUDY AREA

Municipality or Industry	River Mile	Population Total	Population Served	Municipal Water Use Ground MGD	Municipal Water Use Surface MGD	Municipal Total Safe Yield MGD	Industrial Water Use MGD
Androscoggin River							
Sub Area NH-3A							
Berlin	137.0	17,821	19,000	0.40	2.50	X	
Brown Co.	137.0						58.60
Gorham	130.4	3,039	3,240	0.10	0.40	X	
NH-3A Sub total		20,860	22,240	0.50	2.90	X	58.60
Sub Area ME-RA							
Bethel	109.4	2,408	2,410	0.01	.25	.26	
Rumford	86.0	10,005	9,100	0.20	.50	1.0	
Oxford Paper	86.0						46.10
Mexico	86.0	5,043	5,460	0.08	.22	3.38	
Dixfield	82.0	2,323	1,750		.23	.5	
Jay	63.8	3,247	1,565	0.02	.16		
Combined Water Dist.						1.06	
Livermore Falls	61.8	3,343	3,343	0.04	.34		
International Paper	61.8						8.00
Sub total		26,369	23,628	0.35	1.70	6.20	54.10
Little Androscoggin R.							
Paris	30-23	3,601	3,550	0.32		3.45	
Lawrence Leather	30-23						1.26
Norway	30-22	3,733	3,660		0.32	NL	
Oxford	30-19	1,658	200	0.15		.22	
Robinson Mfg.	30-19						1.00
Sub total		8,992	7,410	0.47	0.32	3.67	2.26
ME-RA Sub total		35,361	31,038	0.82	2.02	9.87	56.36

TABLE A-5 Continued

Municipality or Industry	River Mile	Population Total	Population Served	Municipal Water Use Ground MGD	Municipal Water Use Surface MGD	Municipal Total Safe Yield MGD	Industrial Water Use MGD
Androscoggin River							
Sub Area ME-2A							
Bates Mfg. Co.	30.8						.44
Pepperell Mfg. Co.	30.8						1.48
Lewiston	28.8	40,804	47,500		6.50		
Combined Water Dist.						12.0	
Auburn	28.8	24,449	26,000		2.00		
Lisbon	17.7	5,042	6,000	0.45	----	1.5	
Coop. Textile Mill	16.0						.38
U. S. Gypsum Co.	15.7						1.82
Pejepscot Paper Co.	12.7						3.48
Topsham	8.4	3,818	3,818	0.34	----		
Combined Water Dist.						5.0	
Brunswick	8.0	15,797	15,150	1.37	----		
Sub total		89,910	98,468	2.16	8.50	18.50	7.60
Little Androscoggin R.							
Mechanic Falls	30-12	2,195	1,630		0.11	X	
Water Falls Tissue Co.	30-12						2.20
Poland	30-11	1,537	500	0.03		X	
Rogers Fiber Co.	30-11						
Sub total		3,732	2,130	0.03	0.11	X	6.14
ME-2A Sub total		93,642	100,598	2.19	8.61	18.50	13.74
Study Area Total		149,863	153,876	3.51	13.53	28.37	128.70
Androscoggin R. Total		137,139	144,336	3.01	13.10	24.70	120.30
Little Androscoggin R. Total		12,724	9,540	0.50	0.43	3.67	8.40

TABLE A-6

YEAR 2000 WATER REQUIREMENTS OF STUDY AREA

Municipality or Industry	River Mile	Population Total	Population Served	Municipal Water Use (MGD)	Industrial Water Use (MGD)
Androscoggin River					
Subarea NH-3A					
Berlin	137.0	21,400	21,400	3.53	
Brown Co.	137.0				160.00
Gorham	130.4	3,770	3,770	0.62	
NH-3[illegible] Subtotal		25,170	25,170	4.15	160.00
Subarea ME-RA					
Bethel	109.4	2,900	2,900	0.19	
Rumford	86.0	10,800	9,500	0.81	
Oxford Paper Co.	86.0				76.00
Mexico	86.0	6,050	6,050	0.39	
Dixfield	82.0	3,440	2,750	0.41	
International Paper Co.	64.7				44.00
Jay Combined Water Dist.	63.8	4,030	2,400	0.24	
Livermore Falls	61.8	3,620	3,620	0.54	
International Paper Co.	61.8				11.00
Subtotal		30,840	27,220	2.58	131.00
Little Androscoggin River	30.1				
Paris	30-23	5,760	5,760	.66	
Lawrence Leather	30-23				2.42
Norway	30-22	4,030	4,030	.40	
Oxford	30-19	2,320	1,200	.17	
Robinson Mfg.	30-19				1.92
Subtotal		12,110	10,990	1.23	4.34
ME-RA Subtotal		42,950	38,210	3.81	135.34

TABLE A-6 (Cont'd)

Municipality or Industry	River Mile	Population Total	Population Served	Municipal Water Use (MGD)	Industrial Water Use (MGD)
Androscoggin River					
Subarea ME-2A					
Bates Mfg. Co.	30.8				.85
Pepperell Mfg. Co.	30.8				2.84
Lewiston	28.8	44,200	44,200	6.33	
Combined Water Dist.					
Auburn	28.8	31,400	31,400	3.61	
Lisbon	17.7	7,060	7,000	0.70	
Coop. Textile Mill	16.0				.72
U. S. Gypsum Co.	15.7				3.50
Pejepscot Paper Co.	12.7				6.68
Topsham	8.4	6,110	6,100	0.61	
Combined Water Dist.					
Brunswick	8.0	31,600	31,600	3.63	
Subtotal		120,370	120,300	14.88	14.59
Little Androscoggin River					
Mechanic Falls	30-12	2,640	2,200	.18	
Water Falls Tissue Co.	30-12				4.22
Poland	30-11	1,660	800	.06	
Rogers Fiber Co.	30-11				7.56
Subtotal		4,300	3,000	0.24	11.78
ME-2A Subtotal		124,670	123,300	15.12	26.37
Study Area Total		192,790	186,680	23.08	321.71
Androscoggin River Total		176,380	172,690	21.61	305.59
Little Androscoggin River Total		16,410	13,990	1.47	16.12

TABLE A-7

YEAR 2020 WATER REQUIREMENTS OF STUDY AREA

Municipality or Industry	River Mile	Population Total	Population Served	Municipal Water Use (MGD)	Industrial Water Use (MGD)
Androscoggin River					
Subarea NH-3A					
Berlin	137.0	23,200	23,200	3.83	
Brown Co.	137.0				178.00
Gorham	130.4	4,130	4,130	0.68	
NH-3A Subtotal		27,330	27,330	4.51	178.00
Subarea ME-RA					
Bethel	109.4	3,130	3,130	0.25	
Rumford	86.0	11,200	10,400	0.94	
Oxford Paper Co.	86.0				84.00
Mexico	86.0	6,550	6,550	0.52	
Dixfield	82.0	4,000	3,400	0.51	
International Paper Co.	64.7				50.00
Jay	63.8	4,420	3,000	0.35	
Combined Water Dist.					
Livermore Falls	61.8	3,740	3,740	0.56	
International Paper Co.	61.8				14.00
Subtotal		33,040	30,220	3.13	148.00
Little Androscoggin River					
Paris	30-23	6,330	6,330	0.79	
Lawrence Leather	30-23				3.00
Norway	30-22	4,180	4,180	0.48	
Oxford	30-19	2,650	2,100	0.25	
Robinson Mfg. Co.	30-19				2.38
Subtotal		13,160	12,610	1.52	5.38
ME-RA Subtotal		46,200	42,830	4.65	153.38

TABLE A-7 (Cont'd)

Municipality or Industry	River Mile	Population Total	Population Served	Municipal Water Use (MGD)	Industrial Water Use (MGD)
Androscoggin River					
Subarea ME-2A					
Bates Mfg. Co.	30.8				1.05
Pepperell Mfg. Co.	30.8				3.52
Lewiston	28.8	45,800	45,800	7.34	
Combined Water Dist.					
Auburn	28.8	34,800	34,800	4.52	
Lisbon	17.7	8,070	8,000	0.80	
Coop. Textile Mill	16.0				0.89
U. S. Gypsum Co.	15.7				4.34
Pejepscot Paper Co.	12.7				8.28
Topsham	8.4	7,250	7,250	0.72	
Combined Water Dist.					
Brunswick	8.0	39,500	39,500	5.14	
Subtotal		135,420	135,350	18.52	18.08
Little Androscoggin River					
Mechanic Falls	30-12	2,860	2,600	0.23	
Water Falls Tissue Co.	30-12				5.21
Poland	30-11	1,720	1,300	0.12	
Rogers Fiber Co.	30-11				9.37
Subtotal		4,580	3,900	0.35	14.58
ME-2A Subtotal		140,000	139,250	18.87	32.66
Study Area Total		213,530	209,410	28.03	364.04
Androscoggin River Total		195,790	192,900	26.16	344.08
Little Androscoggin River Total		17,740	16,510	1.87	19.96

TABLE A-8

YEAR 2070 WATER REQUIREMENTS OF STUDY AREA

Municipality or Industry	River Mile	Population Total	Population Served	Municipal Water Use (MGD)	Industrial Water Use (MGD)
Androscoggin River					
Subarea NH-3A					
Berlin	137.0	27,600	27,600	4.83	
Brown Co.	137.0				200.00
Gorham	130.4	5,050	5,050	0.86	
NH-3A Subtotal		32,650	32,650	5.69	200.00
Subarea ME-RA					
Bethel	109.4	3,730	3,730	0.37	
Rumford	86.0	12,200	11,750	1.35	
Oxford Paper Co.	86.0				98.00
Mexico	86.0	7,800	7,800	0.78	
Dixfield	82.0	4,700	4,250	0.70	
International Paper Co.	64.7				55.00
Jay	63.8	5,390	4,650	0.61	
Combined Water Dist.					
Livermore Falls	61.8	4,100	4,100	0.68	
International Paper Co.	61.8				16.00
Subtotal		37,920	36,280	4.49	169.00
Little Androscoggin River	30.1				
Paris	30-23	7,720	7,720	1.12	
Lawrence Leather	30-23				3.75
Norway	30-22	4,550	4,550	0.61	
Oxford	30-19	3,480	3,480	0.35	
Robinson Mfg. Co.	30-19				2.98
Subtotal		15,750	15,750	2.08	6.73
ME-RA Subtotal		53,670	52,030	6.57	175.73

TABLE A-8 (Cont'd)

Municipality or Industry	River Mile	Population Total	Population Served	Municipal Water Use (MGD)	Industrial Water Use (MGD)
Androscoggin River					
Subarea ME-2A					
Bates Mfg. Co.	30.8				1.31
Pepperell Mfg. Co.	30.8				4.40
Lewiston	28.8	50,000	50,000	8.25	
Combined Water Dist.					
Auburn	28.8	44,000	44,000	6.60	
Lisbon	17.7	11,000	11,000	1.38	
Coop Textile Mill	16.0				1.11
U. S. Gypsum Co.	15.7				5.42
Pejepscot Paper Co.	12.7				10.37
Topsham	8.4	9,200	9,200	1.15	
Combined Water Dist.					
Brunswick	8.0	49,000	49,000	7.35	
Subtotal		163,200	163,200	24.73	22.61
Little Androscoggin River					
Mechanic Falls	30-12	3,400	3,300	0.35	
Water Falls Tissue	30-12				6.51
Poland	30-11	1,880	1,700	0.18	
Rogers Fiber Co.	30-11				11.71
Subtotal		5,280	5,000	0.53	18.22
ME-2A Subtotal		168,480	168,200	25.26	40.83
Study Area Total		254,800	252,880	37.52	416.56
Androscoggin River Total		233,770	232,130	34.91	391.61
Little Androscoggin River Total		21,030	20,750	2.61	24.95

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TABLE A-9

YEAR 1964 MAJOR WASTE LOADS - MUNICIPAL AND INDUSTRIAL
(P. E. Based on 0.17 lb. 5-Day BOD Per Capita)

Municipality or Industry	River Mile	Population	Municipal MGD	Municipal Treatment	Municipal PE Discharge	Industrial MGD	Industrial Treatment	Industrial PE Discharge
Androscoggin River								
Subarea NH-3A								
Berlin	130.7	17,821	1.60	None	15,000			
Brown Co.	130.7					55.60	None	325,000
Gorham	130.4	3,039	0.28	None	2,500			
NH-3A Sub total		20,860	1.88		17,500	55.60		325,000
Subarea ME-RA								
Bethel	109.4	2,408	0.17	None	1,800			
Rumford	86.0	10,005	0.49	None	9,000			
Oxford Paper Co.	86.0					43.80	None	357,000
Mexico	86.0	5,043	0.22	None	4,000			
Dixfield	82.0	2,323	0.15	None	2,000			
Jay	63.8	3,247	0.12	None	2,000			
Livermore Falls	61.8	3,343	0.25	None	2,800			
International Paper Co.	61.8					7.60	None	217,000
Sub total		26,369	1.40		21,600	51.40		574,000

TABLE A-9 (Continued)

Municipality or Industry	River Mile	Population	Municipal MGD	Municipal Treatment	Municipal PE Discharge	Industrial MGD	Industrial Treatment	Industrial PE Discharge
Little Androscoggin River								
Paris	30-23	3,601	0.16	None	3,550			
Lawrence Leather	30-23					1.20	None	88,200
Norway	30-22	3,733	0.20	None	3,660			
Oxford	30-19	1,658	.08	None	200			
Robinson Mfg. Co.	30-19					0.95	None	14,200
Sub total		8,992	0.46		7,410	2.15		102,400
ME-RA Sub total		35,361	1.86		29,010	53.55		676,400
Androscoggin River								
Subarea ME-2A								
Bates Mfg. Co.	30.8					0.42	None	15,900
Pepperell Mfg. Co.	30.8					1.41	None	16,200
Lewiston	28.8	40,804	4.80	None	35,000			
Auburn	28.8	24,449	1.60	None	18,000			
Lisbon	17.7	5,042	0.29	None	3,000			
Coop. Textile Mill	16.0					0.36	None	15,600
U. S. Gypsum Co.	15.7					1.73	None	39,500
Pejepscot Paper Co.	12.7					3.30	None	28,200
Topsham	8.4	3,818	0.22	None	2,500			
Brunswick	8.0	15,797	0.75	None	15,000			
Sub total		89,910	7.66		73,500	7.22		115,400

TABLE A-9 (Continued)

Municipality or Industry	River Mile	Population	Municipal MGD	Municipal Treatment	Municipal PE Discharge	Industrial MGD	Industrial Treatment	Industrial PE Discharge
Little Androscoggin River								
Mechanic Falls	30-12	2,195	0.07	None	1,630			
Water Falls Tissue Co.	30-12					2.09	None	13,600
Poland	30-11	1,537	0.02	None	500			
Rogers Fiber Co.	30-11					3.74	None	4,720
Sub total		3,732	0.09		2,130	5.83		18,320
ME-2A Sub total		93,642	7.75		75,630	13.05		133,720
Study Area Total		149,863	11.49		122,140	122.20		1,135,120
Androscoggin River Total		137,139	10.94		112,600	114.22		1,014,400
Little Androscoggin River Total		12,724	0.55		9,540	7.98		120,720

TABLE A-10

YEAR 2000 MAJOR WASTE LOADS - MUNICIPAL AND INDUSTRIAL
(P. E. Based on 0.24 lb. 5-Day BOD Per Capita)

Municipality or Industry	River Mile	Population	Municipal MGD	Municipal Treatment	Municipal PE Discharge	Industrial MGD	Industrial Treatment	Industrial PE Discharge
Androscoggin River								
Subarea NH-3A								
Berlin	130.7	21,400	2.15	Secondary	6,000			
Brown Co.	130.7					152.00	Secondary	50,000
Gorham	130.4	3,770	0.37	Secondary	1,050			
NH-3A Sub total		25,170	2.52		7,050	152.00		50,000
Subarea ME-RA								
Bethel	109.4	2,900	0.13	Secondary	750			
Rumford	86.0	10,800	0.58	Secondary	3,180			
Oxford Paper Co.	86.0					72.00	Secondary	60,500
Mexico	86.0	6,050	0.29	Secondary	1,710			
Dixfield	82.0	3,440	0.27	Secondary	990			
International Paper Co.	64.7					42.00	Secondary	56,000
Jay	63.8	4,030	0.16	Secondary	900			
Livermore Falls	61.8	3,620	0.37	Secondary	1,020			
International Paper Co.	61.8					10.00	Secondary	10,500
Sub total		30,840	1.80		8,550	124.00		127,000

TABLE A-10 (Continued)

Municipality or Industry	River Mile	Population	Municipal MGD	Municipal Treatment	Municipal PE Discharge	Industrial MGD	Industrial Treatment	Industrial PE Discharge
Little Androscoggin River								
Paris	30-23	5,760	0.40	Secondary	1,730			
Lawrence Leather	30-23					2.42	Secondary	16,300
Norway	30-22	4,030	0.26	Secondary	1,210			
Oxford	30-19	2,320	0.09	Secondary	480			
Robinson Mfg. Co.	30-19					1.82	Secondary	2,620
Sub total		12,110	0.75		3,420	4.24		18,920
ME-RA Subtotal		42,950	2.55		11,970	128.24		145,920
Androscoggin River								
Subarea ME-2A								
Bates Mfg. Co.	30.8					0.81	Secondary	2,930
Pepperell Mfg. Co.	30.8					2.70	Secondary	3,000
Lewiston	28.8	44,200	4.75	Secondary	12,600			
Auburn	28.8	31,400	2.92	Secondary	8,100			
Lisbon	17.7	7,060	0.47	Secondary	1,800			
Coop. Textile Mill	16.0					0.68	Secondary	2,880
U. S. Gypsum Co.	15.7					3.32	Secondary	6,600
Pejepscot Paper Co.	12.7					6.35	Secondary	5,200
Topsham	8.4	6,110	0.41	Secondary	1,500			
Brunswick	8.0	31,600	2.22	Secondary	9,300			
Sub total		120,370	10.77		33,300	13.86		20,610

TABLE A-10 (Continued)

Municipality or Industry	River Mile	Population	Municipal MGD	Municipal Treatment	Municipal PE Discharge	Industrial MGD	Industrial Treatment	Industrial PE Discharge
Little Androscoggin River								
Mechanic Falls	30-12	2,640	0.12	Secondary	660			
Water Falls Tissue Co.	30-12					4.01	Secondary	2,500
Poland	30-11	1,660	0.04	Secondary	240			
Rogers Fiber Co.	30-11					7.20	Secondary	870
Sub total		4,300	0.16		900	11.21		3,370
ME-2A Sub total		124,670	10.93		34,200	25.07		23,980
Study Area Total		192,790	16.00		53,220	305.31		219,900
Androscoggin River Total		176,380	15.09		48,900	289.86		197,610
Little Androscoggin River Total		16,410	0.91		4,320	15.45		22,290

TABLE A-11

YEAR 2020 MAJOR WASTE LOADS - MUNICIPAL AND INDUSTRIAL
(P. E. Based on 0.24 lb. 5-Day BOD Per Capita)

Municipality or Industry	River Mile	Population	Municipal MGD	Municipal Treatment	Municipal PE Discharge	Industrial MGD	Industrial Treatment	Industrial PE Discharge
Androscoggin River								
Subarea NH-3A								
Berlin	137.0	23,200	2.45	Secondary	3,300			
Brown Co.	137.0					170.00	Secondary	57,000
Gorham	130.4	4,130	0.41	Secondary	600			
NH-3A Sub total		27,330	2.86		3,900	170.00		57,000
Subarea ME-RA								
Bethel	109.4	3,130	0.17	Secondary	450			
Rumford	86.0	11,200	0.69	Secondary	1,650			
Oxford Paper Co.	86.0					80.00	Secondary	67,500
Mexico	86.0	6,550	0.39	Secondary	960			
Dixfield	82.0	4,000	0.35	Secondary	585			
International Paper Co.	64.7					50.00	Secondary	65,500
Jay	63.8	4,420	0.24	Secondary	525			
Livermore Falls	61.8	3,740	0.39	Secondary				
International Paper Co.	61.8					14.00	Secondary	12,900
Sub total		33,040	2.23		4,710	144.00		145,900

TABLE A-11 (Continued)

Municipality or Industry	River Mile	Population	Municipal MGD	Municipal Treatment	Municipal PE Discharge	Industrial MGD	Industrial Treatment	Industrial PE Discharge
Little Androscoggin River								
Paris	30-23	6,330	0.51	Secondary	950			
Lawrence Leather	30-23					2.85	Secondary	20,200
Norway	30-22	4,180	0.34	Secondary	625			
Oxford	30-19	2,650	0.15	Secondary	315			
Robinson Mfg. Co.	30-19					2.26	Secondary	3,230
Sub total		13,160	1.00		1,890	5.11		23,430
ME-RA Sub total		46,200	3.23		6,600	149.11		169,330
Androscoggin River								
Subarea ME-2A								
Bates Mfg. Co.	30.8					1.00	Secondary	3,620
Pepperell Mfg. Co.	30.8					3.34	Secondary	3,700
Lewiston	28.8	45,800	5.50	Secondary	6,920			
Auburn	28.8	34,800	3.66	Secondary	4,650			
Lisbon	17.7	8,070	0.55	Secondary	1,140			
Coop. Textile Mill	16.0					0.84	Secondary	3,570
U. S. Gypsum Co.	15.7					4.12	Secondary	8,950
Pejepscot Paper Co.	12.7					7.87	Secondary	6,620
Topsham	8.4	7,250	0.49	Secondary	970			
Brunswick	8.0	39,500	3.28	Secondary	5,850			
Sub total		135,420	13.48		19,530	17.17		26,460

TABLE A-11 (Continued)

Municipality or Industry	River Mile	Population	Municipal				Industrial		
			MGD	Treatment	PE Discharge		MGD	Treatment	PE Discharge
Little Androscoggin River									
Mechanic Falls	30-12	2,860	0.16	Secondary	390				
Water Falls Tissue Co.	30-12						4.95	Secondary	3,100
Poland	30-11	1,720	0.18	Secondary	195				
Rogers Fiber Co.	30-11						8.90	Secondary	1,070
Sub total		4,580	0.34		585		13.85		4,170
ME-2A Sub total		140,000	13.82		20,115		31.02		30,630
Study Area Total		213,530	19.91		30,615		350.13		256,960
Androscoggin River Total		195,790	18.57		28,140		331.17		229,360
Little Androscoggin River Total		17,740	1.34		2,475		18.96		27,600

TABLE A-12

YEAR 2070 MAJOR WASTE LOADS - MUNICIPAL AND INDUSTRIAL

(P. E. Based on 0.27 lb. 5-Day BOD Per Capita)

Municipality or Industry	River Mile	Popultaion	Municipal			Industrial		
			MGD	Treatment	PE Discharge	MGD	Treatment	PE Discharge
Androscoggin River								
Subarea NH-3A								
Berlin	130.7	27,600	3.48	Secondary	4,050			
Brown Co.	130.7					191.00	Secondary	63,500
Gorham	130.4	5,050	0.56	Secondary	750			
NH-3A Sub total		32,650	4.04		4,800	191.00		63,500
Subarea ME-RA								
Bethel	109.4	3,730	0.26	Secondary	555			
Rumford	86.0	12,300	1.03	Secondary	1,800			
Oxford Paper Co.	86.0					95.00	Secondary	66,500
Mexico	86.0	7,800	0.58	Secondary	1,150			
Dixfield	82.0	4,700	0.49	Secondary	697			
International Paper Co.	64.7					52.00	Secondary	65,500
Jay	63.8	5,390	0.44	Secondary	750			
Livermore Falls	61.8	4,100	0.50	Secondary	600			
International Paper Co.	61.8					15.00	Secondary	12,600
Sub total		37,920	3.30		5,552	162.00		144,600

TABLE A-12 (Continued)

Municipality or Industry	River Mile	Population	Municipal MGD	Municipal Treatment	Municipal PE Discharge	Industrial MGD	Industrial Treatment	Industrial PE Discharge
Little Androscoggin River								
Paris	30-23	7,720	0.78	Secondary	1,160			
Lawrence Leather	30-23					3.56	Secondary	22,500
Norway	30-22	4,550	0.43	Secondary	680			
Oxford	30-19	3,480	0.23	Secondary	480			
Robinson Mfg. Co.	30-19					2.83	Secondary	3,580
Sub total		15,750	1.44		2,320	6.39		26,080
Sub total ME-RA		53,670	4.74		7,872	168.39		170,680
Androscoggin River								
Subarea ME-2A								
Bates Mfg. Co.	30.8					1.25	Secondary	4,030
Pepperell Mfg. Co.	30.8					4.20	Secondary	4,100
Lewiston	28.8	50,000	6.35		7,350			
Auburn	28.8	44,000	5.40		6,300			
Lisbon	17.7	11,000	0.99		1,575			
Coop. Textile Mill	16.0					1.05	Secondary	3,960
U. S. Gypsum Co.	15.7					5.15	Secondary	10,000
Pejepscot Paper Co.	12.7					9.85	Secondary	7,320
Topsham	8.4	9,200	0.80		1,350			
Brunswick	8.0	49,000	7.35	Secondary	7,350			
Sub total		163,200	20.89		23,925	21.50		29,410

TABLE A-12 (Continued)

Municipality or Industry	River Mile	Population	Municipal MGD	Municipal Treatment	Municipal PE Discharge	Industrial MGD	Industrial Treatment	Industrial PE Discharge
Little Androscoggin River								
Mechanic Falls	30-12	3,400	0.25	Secondary	500			
Water Falls Tissue Co.	30-12					6.20	Secondary	3,420
Poland	30-11	1,800	0.13	Secondary	260			
Rogers Fiber Co.	30-11					11.12	Secondary	1,190
Sub total		5,200	0.38		760	17.32		4,610
ME-2A Sub total		168,400	21.27		24,685	38.82		34,020
Study Area Total		254,720	30.05		37,357	398.21		268,200
Androscoggin River Total		233,770	28.23		34,277	374.50		237,510
Little Androscoggin River Total		20,950	1.82		3,080	23.71		30,690

TABLE A-13

ANDROSCOGGIN RIVER

SELECTED VALUES FOR COMPUTER ANALYSIS

RIVER TEMPERATURE 20°C

Upstream Station (River Miles)	Down-Stream Station (River Miles)	Velocity (ft/sec)	K_1Deoxygenation Const. Base 10/day	K_2Reaeration Const. Base 10/day	F (K_2/K_1)
138.8	130.4	1.00	0.27	0.41	1.52
130.4	119.2	1.00	0.27	0.41	1.52
119.2	109.4	1.66	0.25	0.12	0.48
109.4	96.8	1.13	0.20	0.34	1.70
96.8	87.6	0.69	0.34	0.22	0.65
87.6	87.0	0.69	0.33	0.56	1.70
87.0	86.0	0.69	0.20	0.54	2.70
86.0	82.0	1.41	0.20	0.54	2.70
82.0	78.6	1.41	0.20	0.54	2.70
78.6	71.7	1.06	0.20	0.54	2.70
71.7	66.6	0.32	0.25	0.33	1.32
66.6	63.8	0.37	0.16	0.11	0.69
63.8	61.8	0.40	0.47	0.52	1.11
61.8	53.2	0.83	0.27	0.46	1.70
53.2	49.0	0.83	0.27	0.46	1.70
49.0	42.6	0.26	0.16	0.07	0.44
42.6	42.0	0.06	0.03	0.00	0.00
42.0	34.8	0.06	0.03	0.00	0.00
34.8	33.7	0.42	0.95	0.38	0.40
33.7	30.8	0.42	0.70	0.21	0.30
21.2	16.0	0.92	0.15	UNK	UNK
12.7	8.4	0.76	0.54	0.76	1.41

TABLE A-14

NEW ENGLAND INTERSTATE WATER POLLUTION CONTROL COMMISSION

CLASSIFICATION AND STANDARDS OF QUALITY FOR INTERSTATE WATERS

(As Revised and Adopted October 1, 1959)

SUITABILITY FOR USE

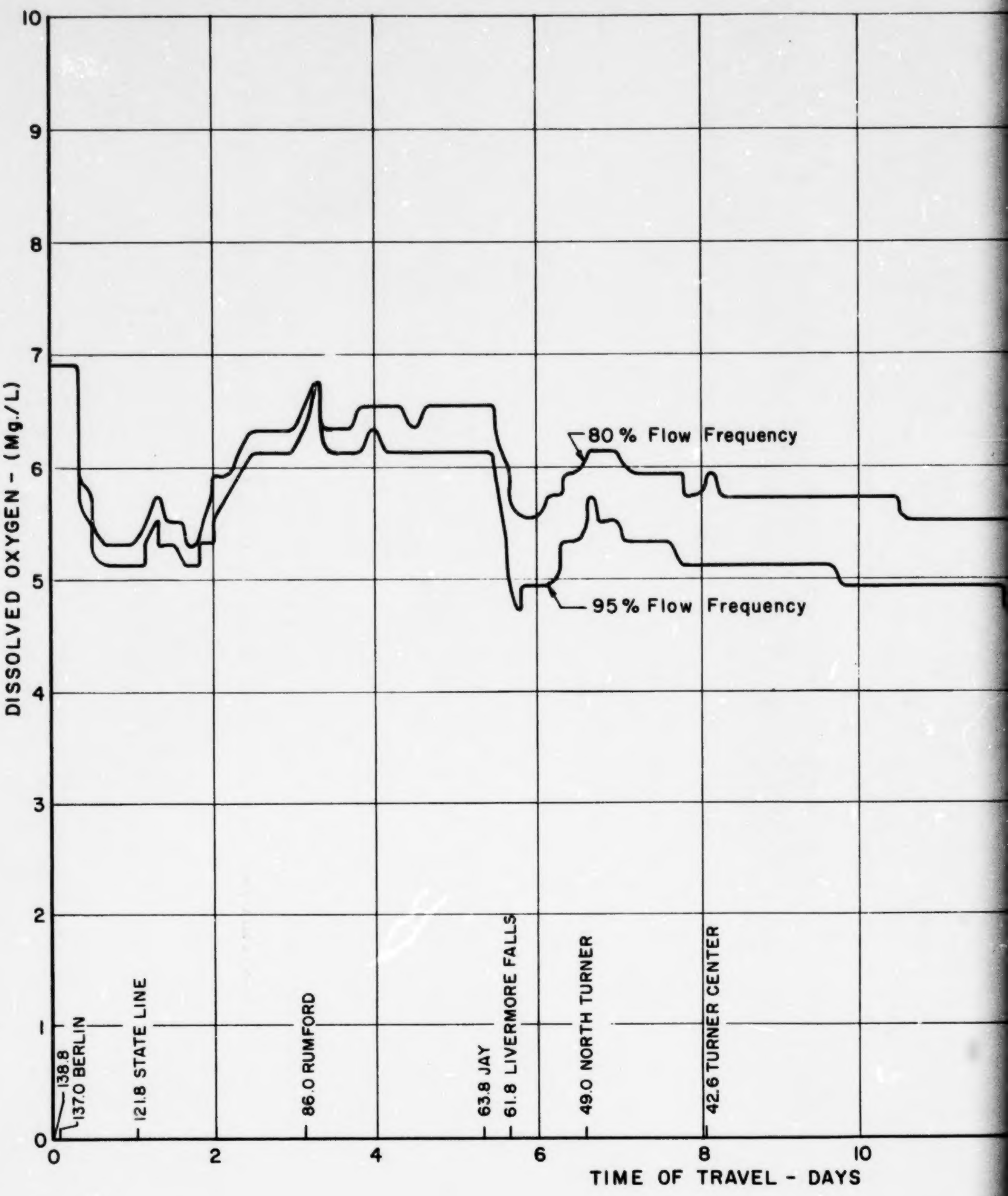
	CLASS A	CLASS B	CLASS C	CLASS D
	Suitable for any water use. Character uniformly excellent.	Suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value. Acceptable for public water supply with filtration and disinfection.	Suitable for recreational boating, irrigation of crops not used for consumption without cooking; habitat for wildlife and common food and game fishes indigenous to the region; industrial cooling and most industrial process uses.	Suitable for transportation of sewage and industrial wastes without nuisance, and for power, navigation and certain industrial uses.

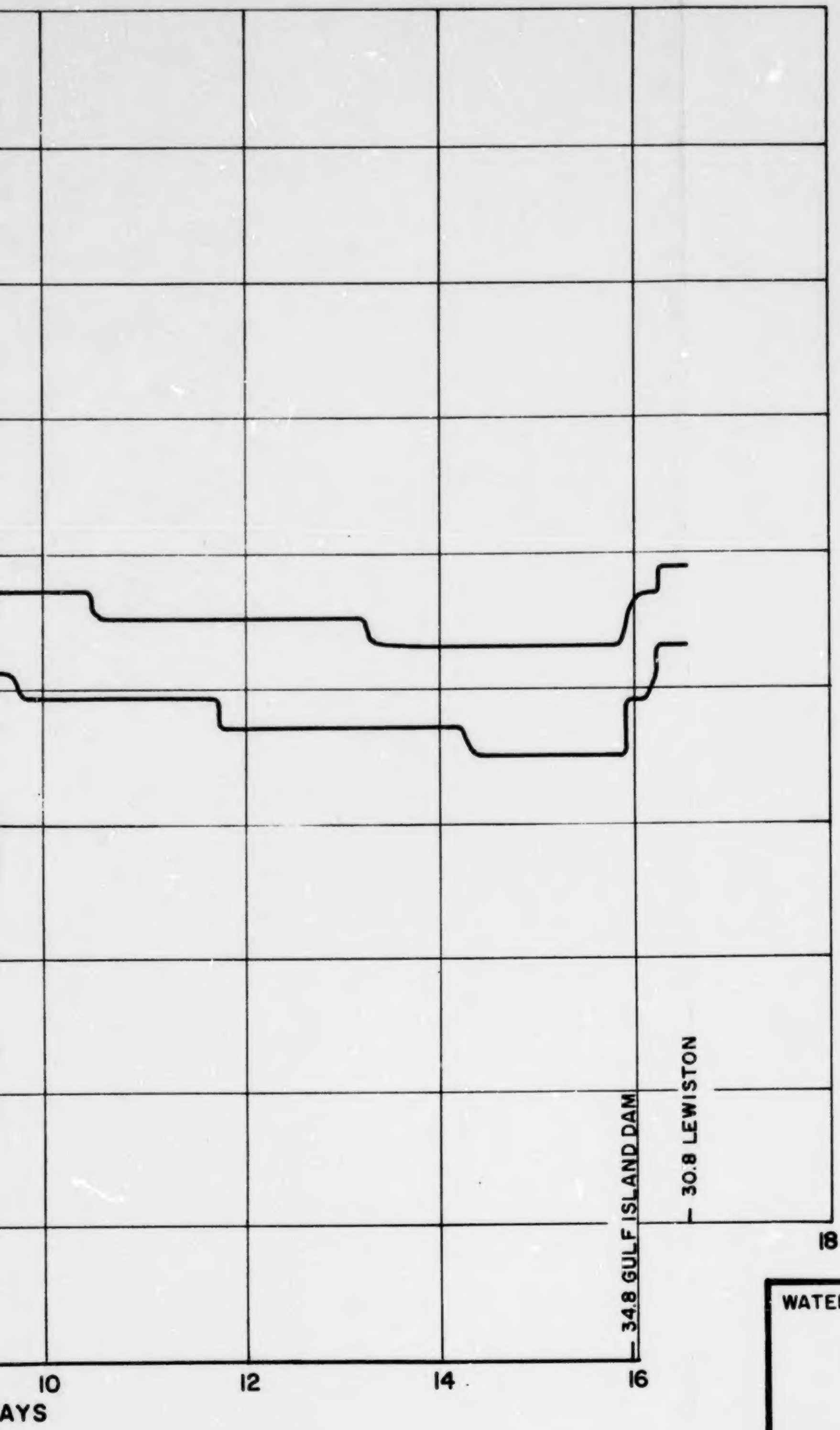
STANDARDS OF QUALITY

	CLASS A	CLASS B	CLASS C	CLASS D
Dissolved oxygen	Not less than 75% sat.	Not less than 75% sat.	Not less than 5 p.p.m.	Present at all times
Oil and grease	None	No appreciable amount	Not objectionable	Not objectionable
Odor, scum, floating solids, or debris	None	None	None	Not objectionable
Sludge deposits	None	None	None	Not objectionable
Color and turbidity	None	Not objectionable	Not objectionable	Not objectionable
Phenols or other taste producing substances	None	None	None	
Substances potentially toxic	None	None	Not in toxic concentrations or combinations	Not in toxic concentrations or combinations
Free acids or alkalies	None	None	None	Not in objectionable amounts
Radioactivity	Within limits approved by the appropriate State agency with consideration of possible adverse effects in downstream waters from discharge of radioactive wastes; limits in a particular watershed to be resolved when necessary after consultation between States involved.			
Coliform bacteria	*Within limits approved by State Department of Health for uses involved.	Bacterial content of bathing waters shall meet limits approved by State Department of Health and acceptability will depend on sanitary survey.		

**Sea waters used for the taking of market shellfish shall not have a median coliform content in excess of 70 per 100 ml.*

NOTE: Waters failing below these descriptions are considered as unsatisfactory and as Class E.
These standards do not apply to conditions brought about by natural causes.
For purpose of distinction as to use, waters used or proposed for public water supply shall be so designated.


DISSOLVED OXYGEN - (Mg./L)
10
9
8
7
6
5
4
3
2
1
0
TIME OF TRAVEL - DAYS
0
2
4
6
8
10
80 % Flow Frequency
95 % Flow Frequency
138.8
137.0 BERLIN
121.8 STATE LINE
86.0 RUMFORD
63.8 JAY
61.8 LIVERMORE FALLS
49.0 NORTH TURNER
42.6 TURNER CENTER



Note:

Water temperature 25° C.

95 % flow frequency at Berlin, N. H. is 1490 cfs.

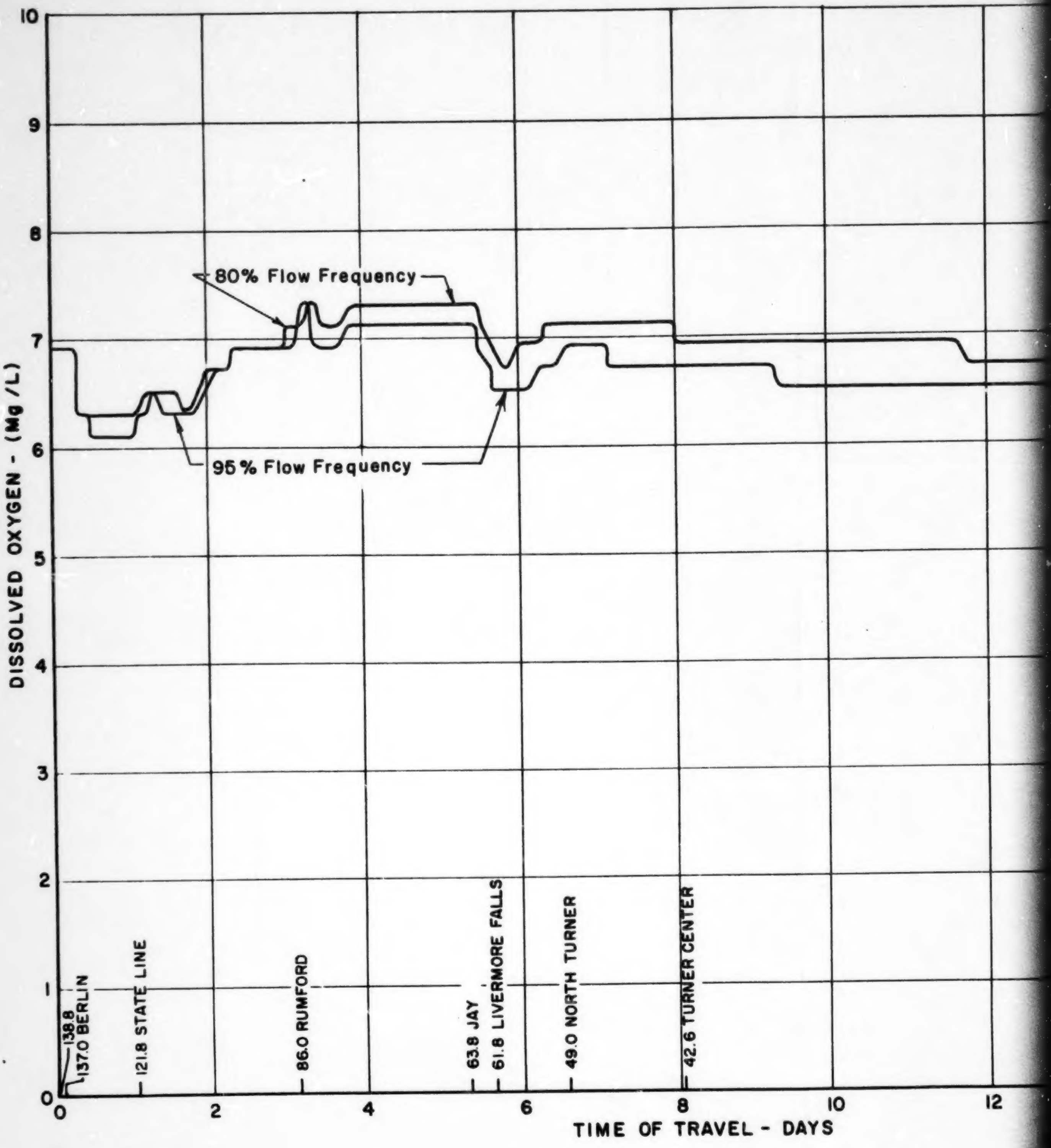
80 % flow frequency at Berlin, N. H. is 1650 cfs.

WATER SUPPLY AND WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN, N.H. ME.

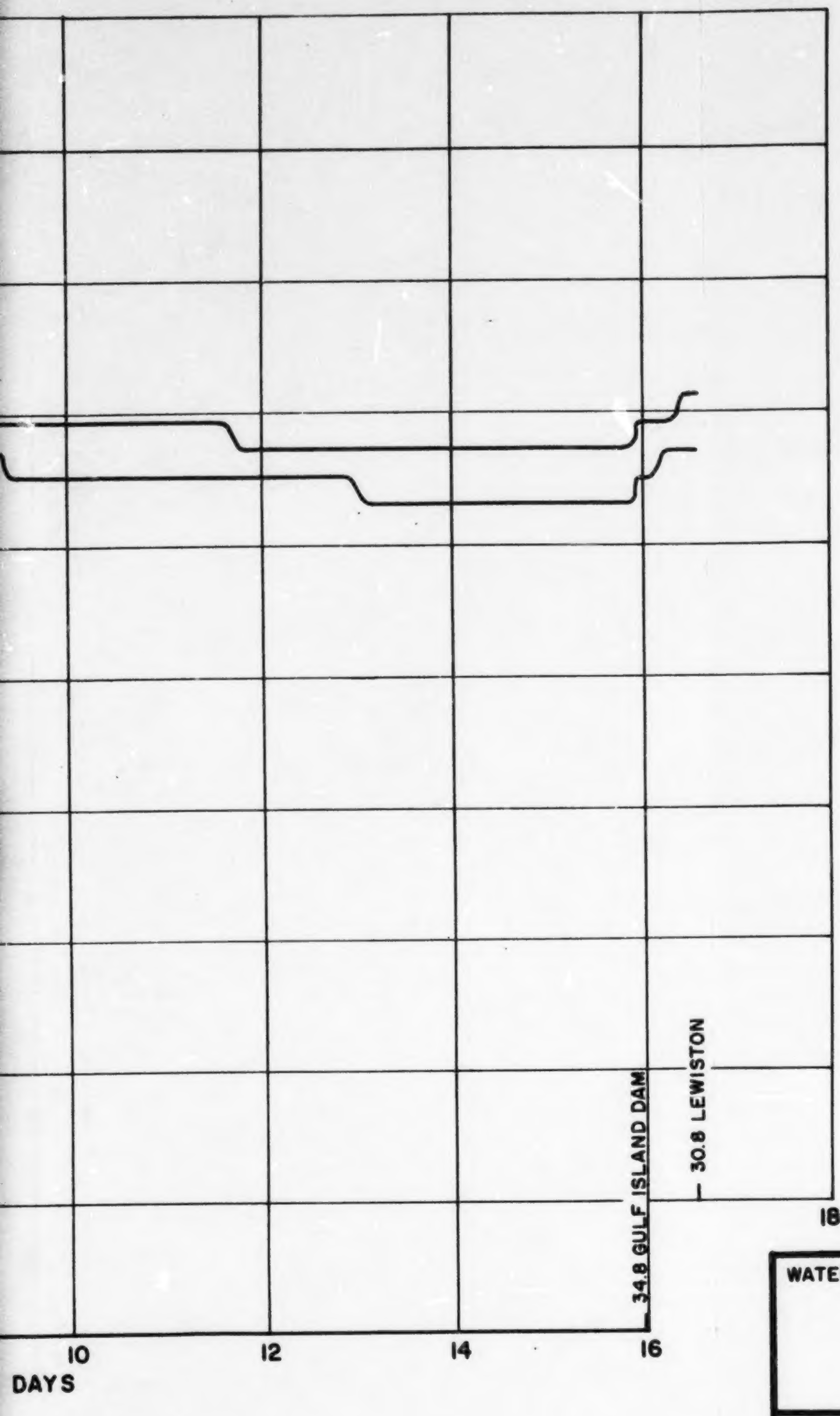
DOUBLE 2070 WASTES - EFFECT OF FLOW ON DISSOLVED OXYGEN

U.S. DEPARTMENT OF HEALTH EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE A-3



DISSOLVED OXYGEN - (Mg/L)
10
9
8
7
6
5
4
3
2
1
0
80% Flow Frequency
95% Flow Frequency
138.8
137.0 BERLIN
121.8 STATE LINE
86.0 RUMFORD
63.8 JAY
61.8 LIVERMORE FALLS
49.0 NORTH TURNER
42.6 TURNER CENTER
0
2
4
6
8
10
12
TIME OF TRAVEL - DAYS



Note:

Water temperature 25° C.
95 % flow frequency at
Berlin, N.H. is 1490 cfs.
80 % flow frequency at
Berlin, N.H. is 1650 cfs.

WATER SUPPLY AND WATER QUALITY CONTROL STUDY
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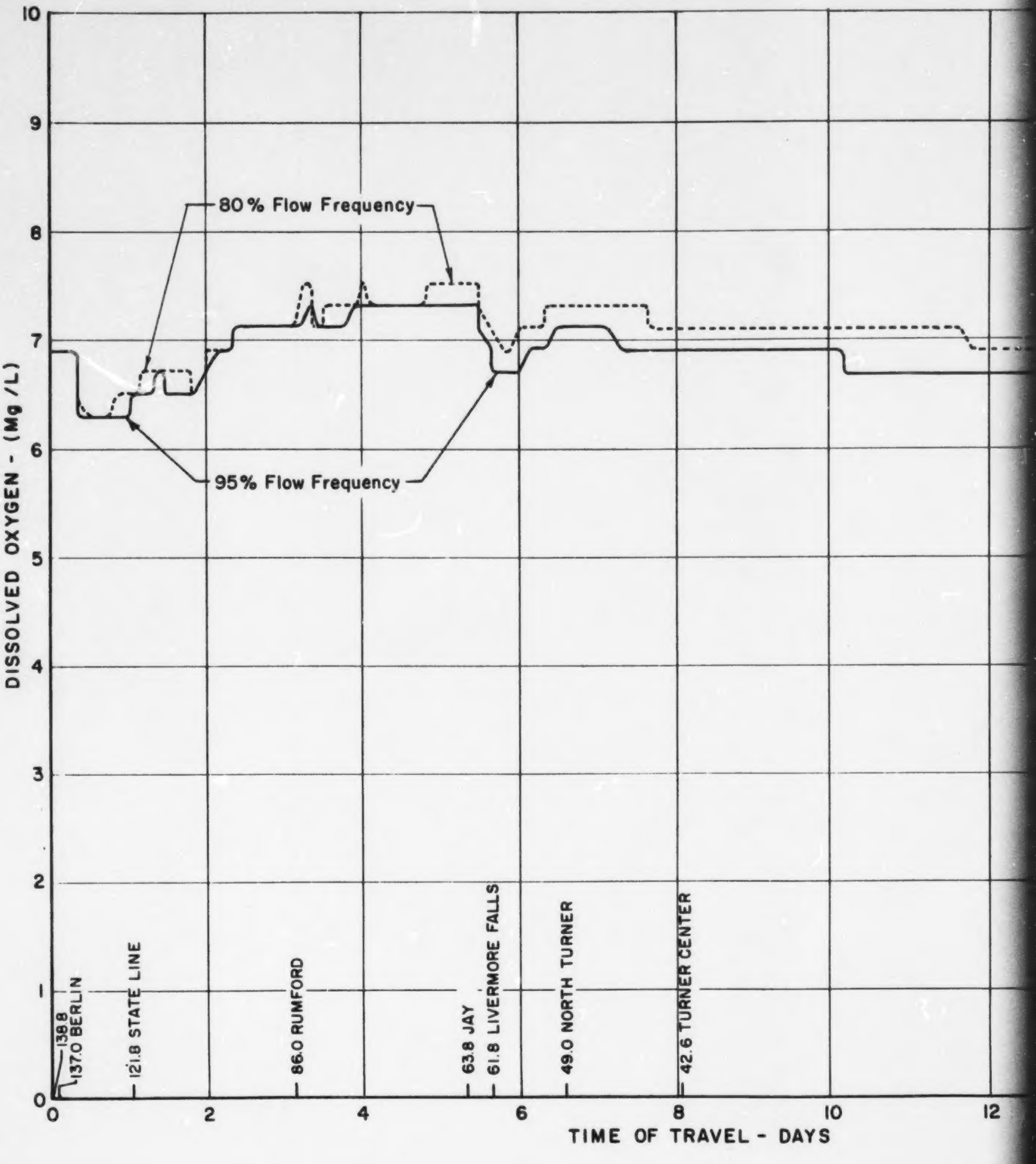
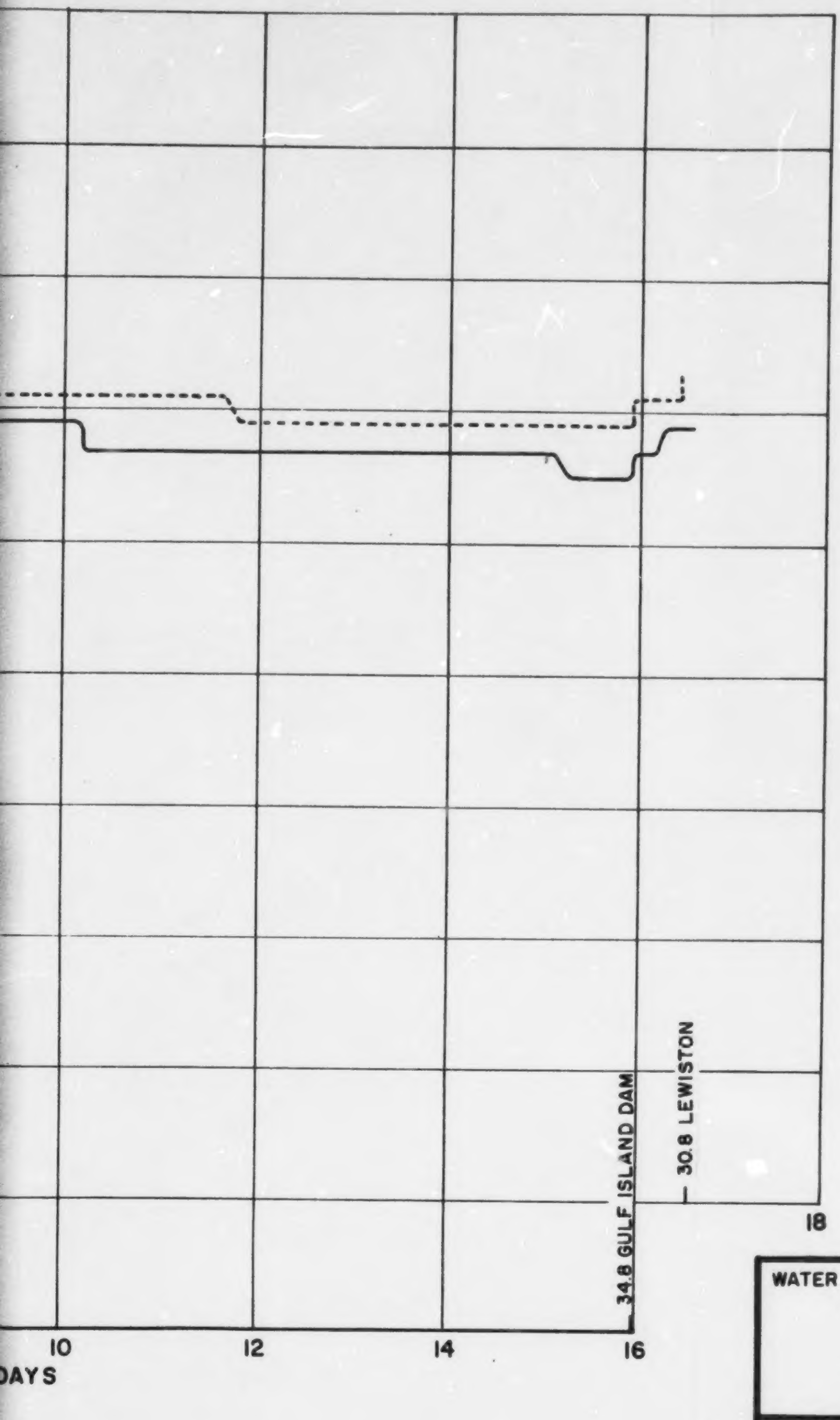
2070 WASTES-
EFFECT OF FLOW ON
DISSOLVED OXYGEN

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE A-4



DISSOLVED OXYGEN - (Mg /L)
TIME OF TRAVEL - DAYS
10
9
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10
12
80% Flow Frequency
95% Flow Frequency
138.8
137.0 BERLIN
121.8 STATE LINE
86.0 RUMFORD
63.8 JAY
61.8 LIVERMORE FALLS
49.0 NORTH TURNER
42.6 TURNER CENTER



Note:

Water temperature 25° C.

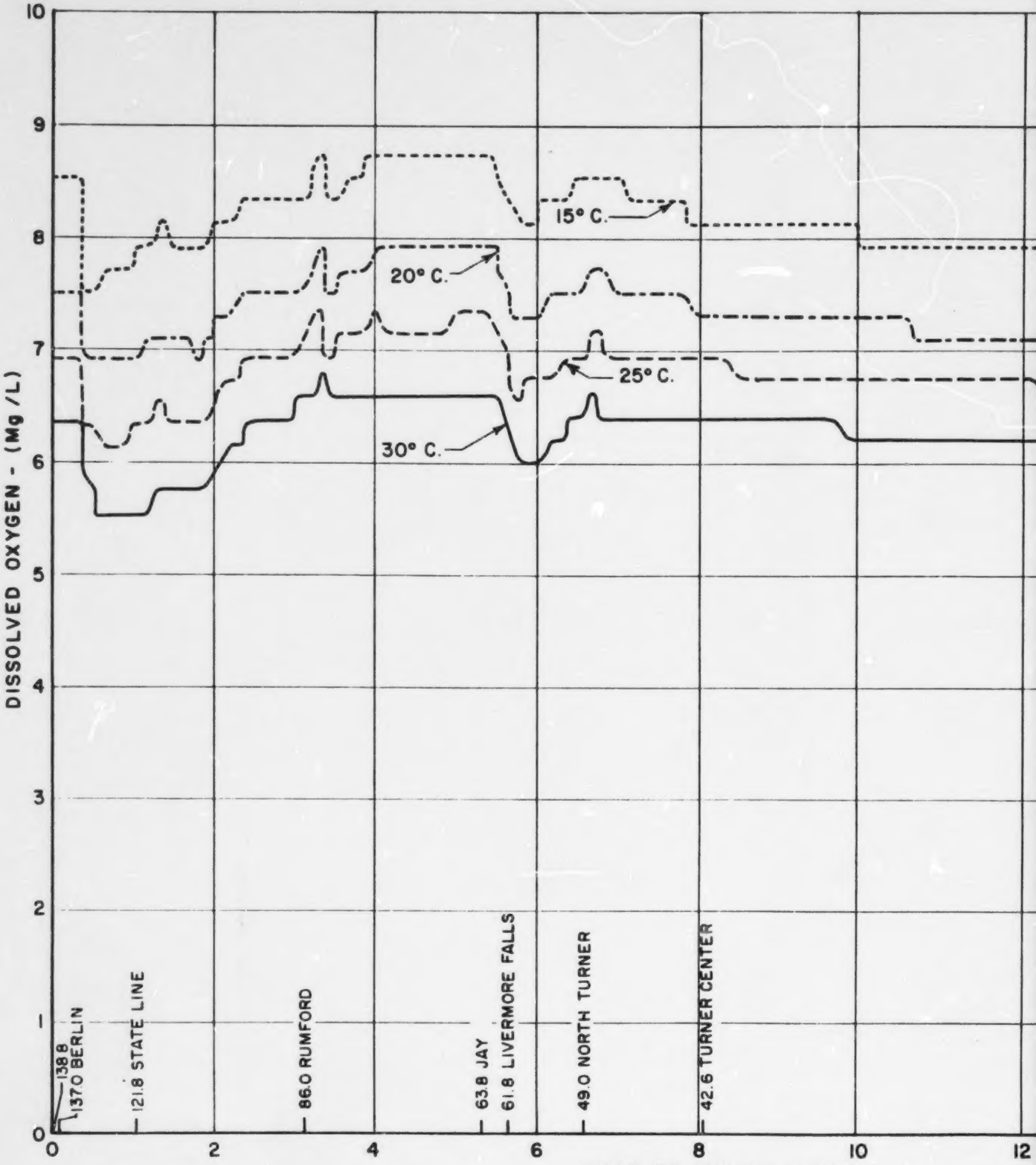
95% flow frequency at Berlin, N. H. is 1490 cfs.

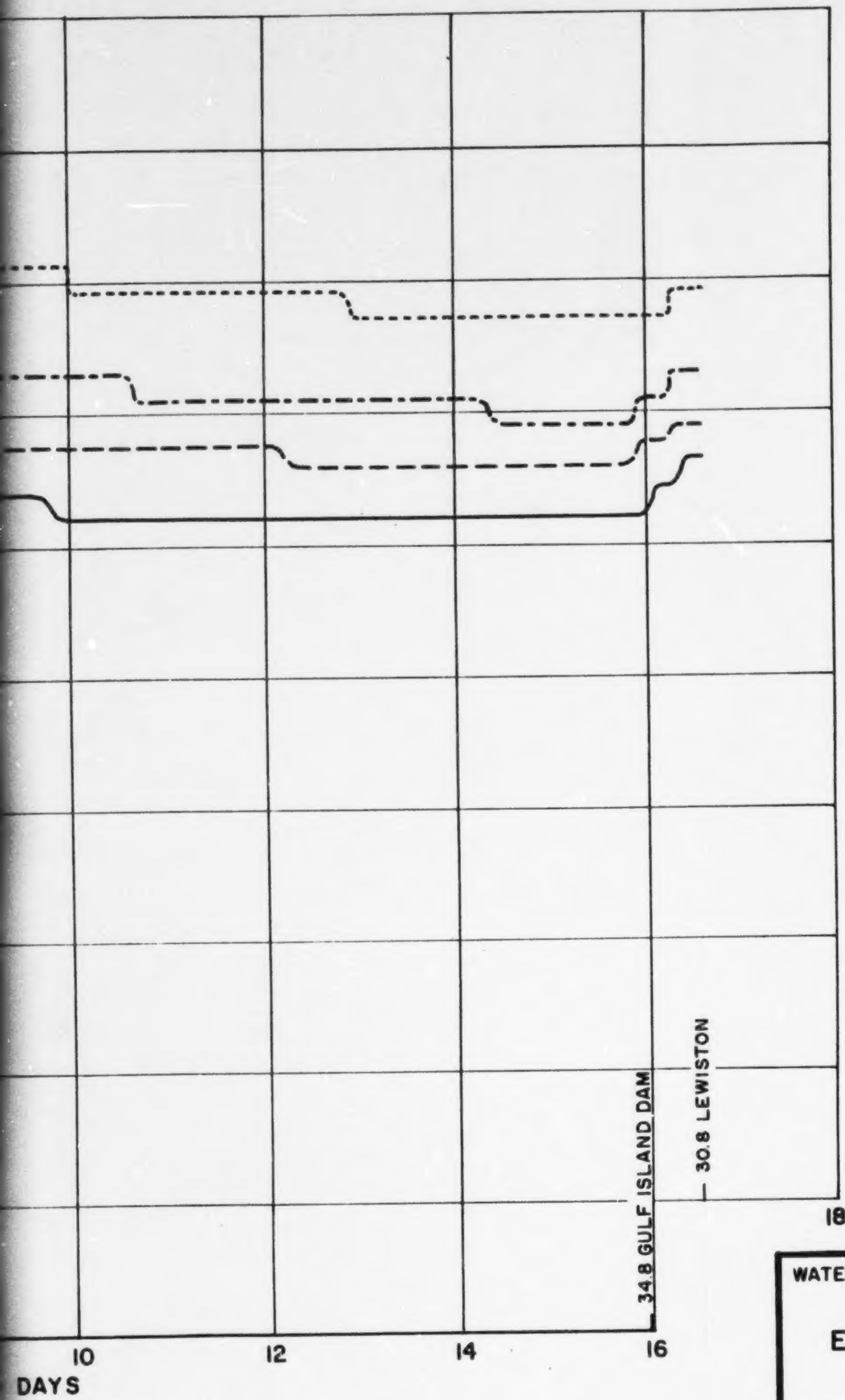
80% flow frequency at Berlin, N. H. is 1650 cfs.

WATER SUPPLY AND WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN, N.H., ME.
2020 WASTES-
EFFECT OF FLOW ON
DISSOLVED OXYGEN

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION I BOSTON, MASS.

FIGURE A-5


DISSOLVED OXYGEN - (Mg /L)
10
9
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10
12
TIME OF TRAVEL - DAYS
15° C.
20° C.
25° C.
30° C.
138.8
137.0 BERLIN
121.8 STATE LINE
86.0 RUMFORD
63.8 JAY
61.8 LIVERMORE FALLS
49.0 NORTH TURNER
42.6 TURNER CENTER



Note:

Curves are for 2070 waste load
and initial flow of 1560 cfs.
that is expected 90% of the time.

WATER SUPPLY AND WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN, N.H., ME.

EFFECT OF TEMPERATURE ON DISSOLVED OXYGEN

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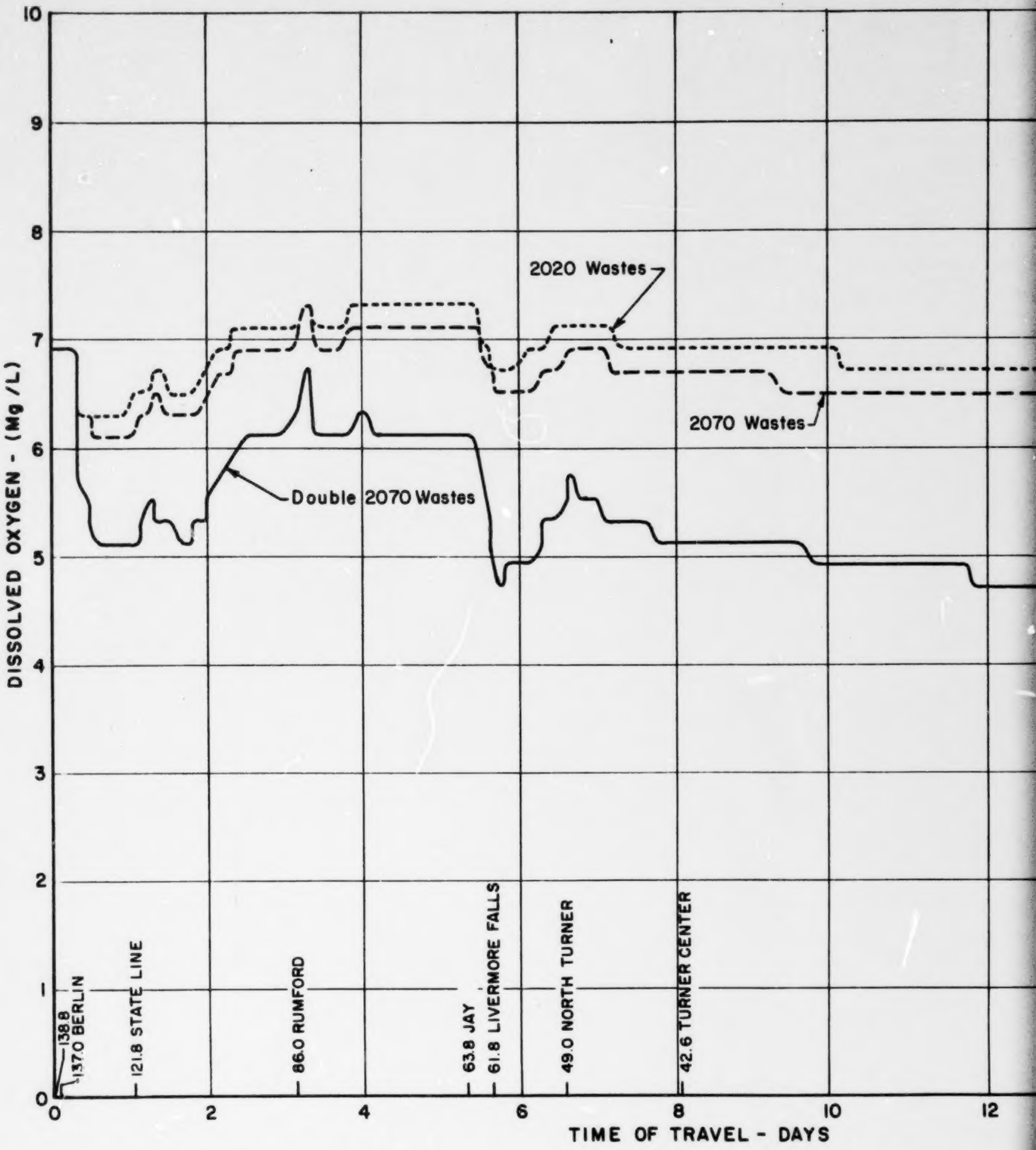
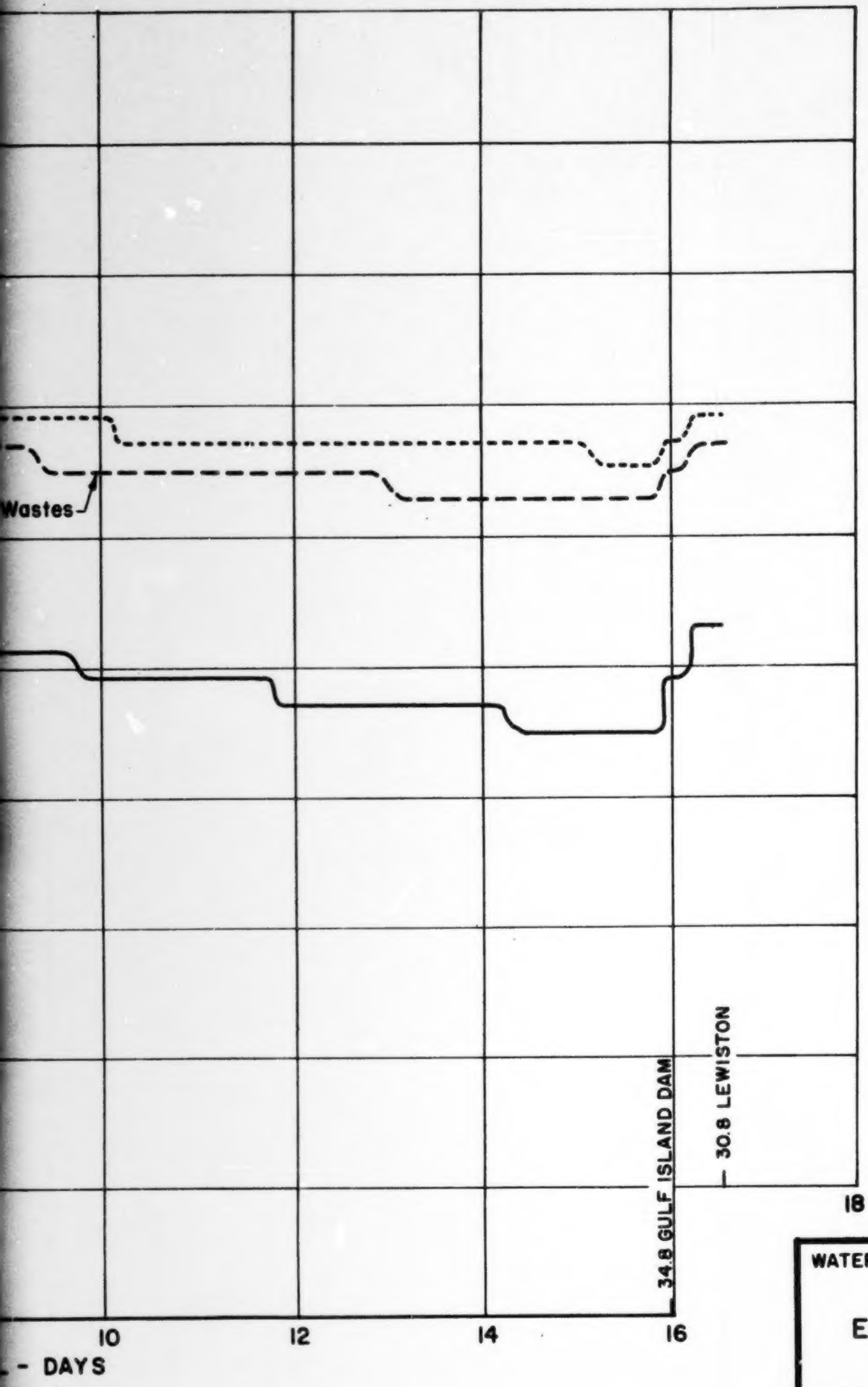
FIGURE A-6


DISSOLVED OXYGEN - (Mg /L)
0
1
2
3
4
5
6
7
8
9
10
TIME OF TRAVEL - DAYS
0
2
4
6
8
10
12
2020 Wastes
2070 Wastes
Double 2070 Wastes
138.8
137.0 BERLIN
121.8 STATE LINE
86.0 RUMFORD
63.8 JAY
61.8 LIVERMORE FALLS
49.0 NORTH TURNER
42.6 TURNER CENTER



Note:
Curves are for 25° C. and initial flow of 1490 cfs to be expected 95% of the time.

WATER SUPPLY AND WATER QUALITY CONTROL STUDY
ANDROSCOGGIN RIVER BASIN, N.H., ME.

EFFECT OF WASTE LOAD ON DISSOLVED OXYGEN

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
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FIGURE A-7